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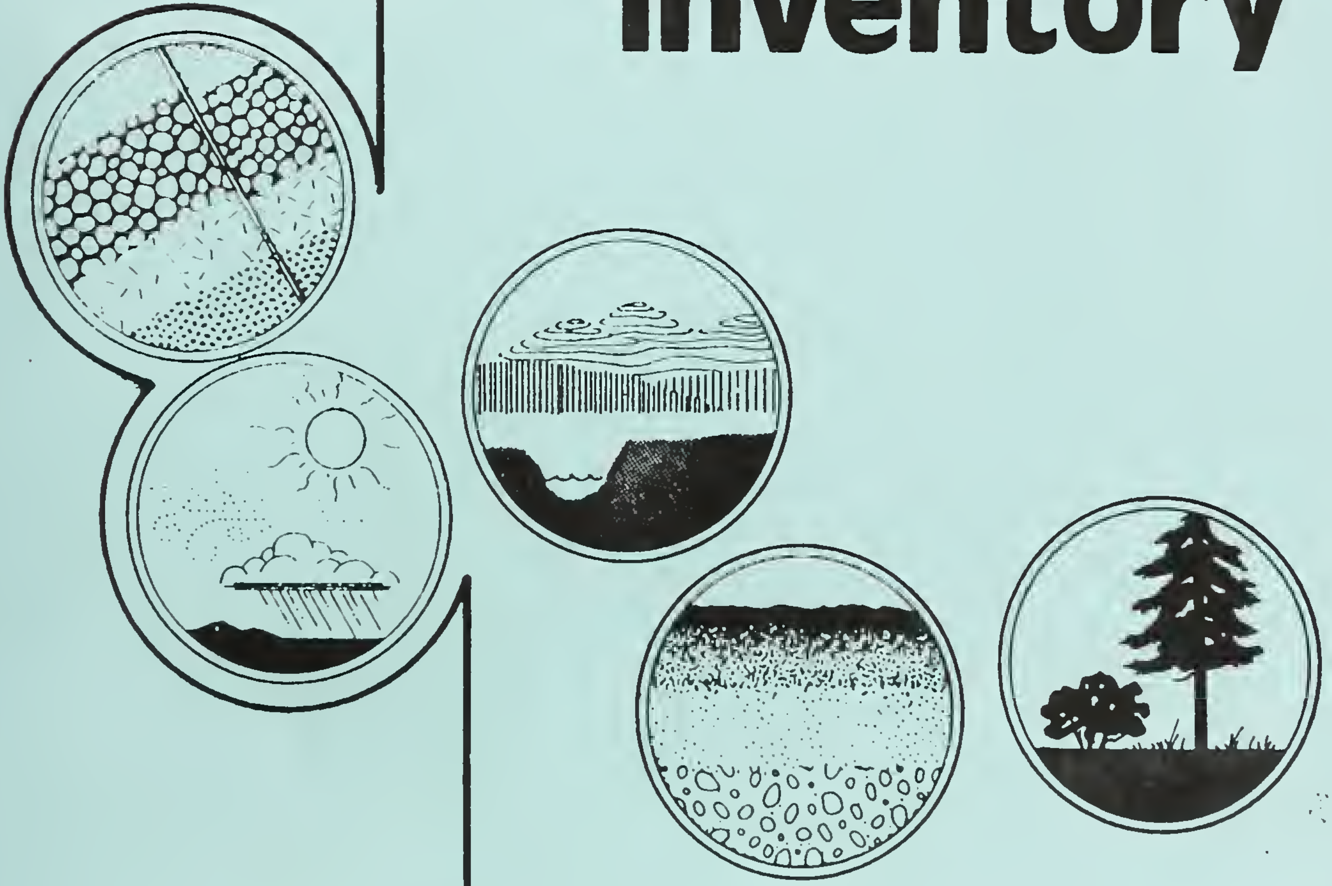

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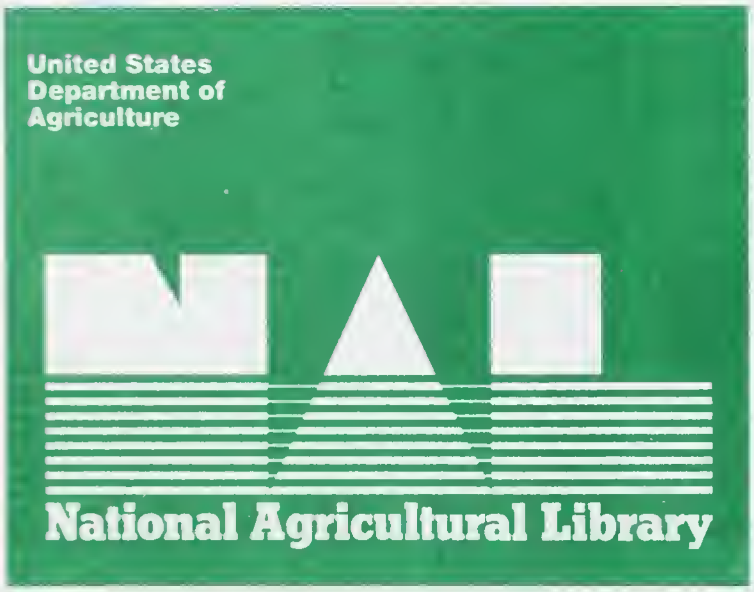
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LAND SYSTEM INVENTORY GUIDE

JULY 1976

U. S. FOREST SERVICE
NORTHERN REGION
MISSOULA, MONTANA 59801

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PREFACE

Soil scientists in the Northern Region have been classifying and mapping National Forest lands since 1970 using a system of land classification designed specifically to provide the kinds of soil and watershed information needed for land use planning on National Forests of the Northern Region.

The system is designed to meet several specific Forest Service land inventory objectives:

1. Provide a system of different levels of inventory whereby large tracts of land can be rapidly inventoried for broad overview purposes or in setting up detailed inventories that will meet the needs of land managers.

2. Permit the best possible inventories, considering limited manpower and money.

3. Collecting reliable data that can be used as a basis for land management decisions.

4. Presenting data in a manner that users can relate to and understand.

5. Interpreting data needed for designs regarding various land management activities.

The land system inventory is devised to meet specific land use planning objectives which relate to all other resource systems of land classification. This handbook is intended to define and assign class differentiating criteria to the landtype level in the land system inventory as it is presently used in Region 1. These differentiations are meant to be flexible enough to allow individual Forest soil scientists to tailor their mapping legends to suit local conditions but within the framework of the land system inventory. The orientation of this handbook is necessarily restricted to a relatively narrow section of the whole land system inventory scheme--the landtype--since this is the level at which inventory is presently being conducted. As the inventory is expanded to other levels of definition, the differentiating criteria for other levels in the system will be defined.

The inventory of land resources in the United States has been heavily dependent upon separate geologic and soil inventory systems. The geologic inventory is generally tied to the delineation of relative position and character of bedrock and geomorphology. The soil inventory has been tied to the soil taxonomic system in use by the National Cooperative Soil Survey. This guide incorporates aspects of both systems as well as a habitat type classification.

These inventory procedures have been developed and tested in the field and are now being applied in Region 1. They have been a continuing evolutionary process, and we expect more refinements to be added as a result of extensive work. The system could not have been perfected to its present status without the development of the Forest and Range Habitat Types for Montana by Dr. Robert Pfister,(9) of the Intermountain Forest and Range Experiment Station.

We would also like to acknowledge the contribution of Dick Alvis, soil scientist, White Mountain National Forest. Without Dick's early work, we would not be where we are today.

Soil scientists in Region 1 have contributed to the system's conceptual development and implementation through their field work and testing, including the writing of this guide. The following is a list of these soil scientists.

E. M. Richlen	Regional Office
Roger Poff	Beaverhead National Forest
Norman Davis	Bitterroot National Forest
Dale Wilson	Clearwater National Forest
Dr. Gordon Warrington	Idaho Panhandle National Forests
Karl Krueger	Idaho Panhandle National Forests
Norman Yogerst	Idaho Panhandle National Forests
Al Martinson	Flathead National Forest
Larry Ross	Flathead National Forest
Carl Davis	Gallatin National Forest
Louis Kuennen	Kootenai National Forest
Herb Holdorf	Lewis & Clark National Forest
Stan Peterson	Lolo National Forest
Dr. Richard Cline	Nezperce National Forest

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PART I

LAND SYSTEM INVENTORY

LAND SYSTEM INVENTORY

- U.S. FOREST SERVICE -
NORTHERN REGION

A. INTRODUCTION

The land system inventory is a hierarchical system of land inventory containing seven levels. In the first three levels the province, section and subsection are defined by climatic and geologic properties of land. In the lowest four levels--the landtype assocation, landtype, landtype phase and site--the classes within categories are defined by properties of soils, landforms and climax plant communities. Each of the inventory levels provides land resource data appropriate for specific planning needs. The classes in each level can be subdivided to provide more specific data at a lower level of inventory or aggregated together to provide more general data at a higher level.

The landtype level is the most commonly used for National Forest land use planning. This handbook deals primarily with inventories at the landtype level.

A tentative classification of lands in the Northern Region at the province, section and subsection levels has been developed and is presented here as a basis for discussion of classification at these levels.

Wertz and Arnold(13) suggested using Thornbury's(11) definition of physiographic provinces at these levels. Recently, Baily(3) proposed a classification which uses climatic criteria for the first stratification at these levels and physiography as a criteria for secondary subdivision. This approach seems to yield classes of a more uniform nature and has been adapted with the modification that the classes are considered reoccurring mapping units without defined location. The other proposed classifications consider the classes in these categorical levels to have defined location.

The use of climate as differentiating criteria in lands of high relief and vertical climatic conditions creates the potential for small delineations at high categorical levels. Consequently, most mountain land classes at these categorical levels have inclusions of geomorphically similar lands in adjacent climatic classes.

Classes at the section level named after the same climax dominants in different provinces are unique units with different associated plant species and significant differences in potential productivity. For example, the Douglas Fir - Ponderosa Pine Section in the Rocky Mountain Highland Province.

The following key shows the relationships of the proposed classes at these categorical levels.

KEY TO NORTHERN REGION SUBSECTIONS

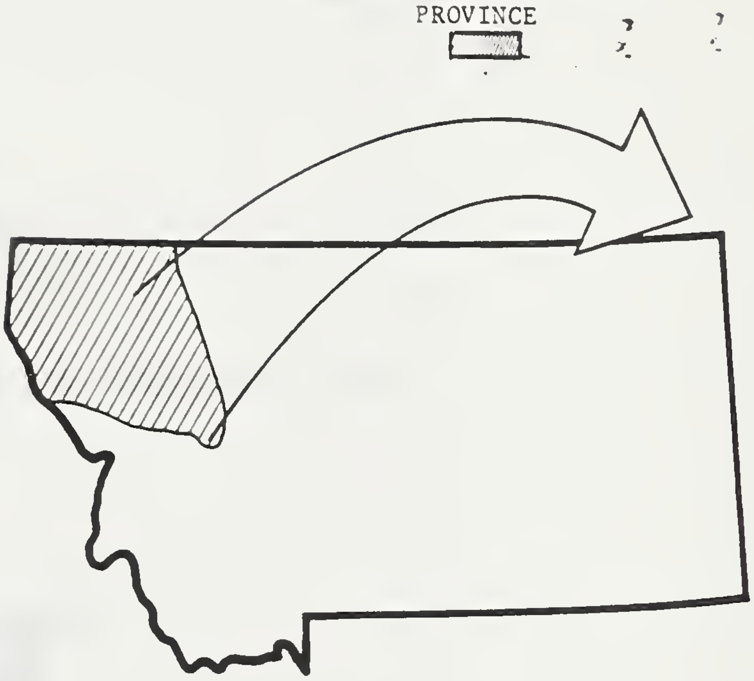
I. Columbia Forest Highland Province	
A. Alpine Fir - Douglas Fir - Cedar - Hemlock Section	
1. Glacial deposition basins	B4
2. Glacial deposition mountains	M9
3. Noncarbonate belt rock mountains	M13
4. Carbonate belt rock mountains	M14
5. Belt rock fault escarpments	M15
6. Belt rock dip slopes	M16
7. Gneiss and schist mountains	M17
8. Gneiss and schist fault escarpments	M19
9. Granite mountains	M22
10. Lava flow plateaus	M23
11. River breaklands	M24
B. Hemlock - Douglas Fir Section	
1. Glacial deposition basins	B6
C. Ponderosa Pine - Douglas Fir Section	
1. Carbonate belt rock mountains	M7
2. River breaklands	M12
3. Lava flow plateaus	M21
4. Noncarbonate belt rock mountains	M25
D. Azonal: Topo-Edaphic Climax	
D1 - Cottonwood - Shrub - Bunchgrass Section	
1. Floodplains	A2
D2 - Alpine Turf - Alpine Fir - Spruce Section	
1. Alpine ridges, peaks and glacial cirques	M10

D3 - Idaho Fescue - Bluebunch Wheatgrass Section	
1. Mountain grasslands	M4
II. Rocky Mountain Forested Highlands (Continental)	
A. Alpine Fir - Douglas Fir Section	
1. Glacial deposition basins	B5
2. Metamorphic rock mountains	M3
3. Soft sedimentary rock mountains	M6
4. Granitic mountains	M8
5. Very steep volcanic rock mountains	M18
6. Rolling volcanic rock mountains	M20
B. Douglas Fir - Ponderosa Pine Section	
1. All rocks except limestone and granite mountains	M1
2. Limestone mountains	M2
C. Azonal: Topo-Edaphic Climax	
C1 - Alpine Turf - Alpine Fir - Spruce Section	
1. Overthrust mountains	M5
2. Alpine ridges, peaks and glacial cirques	M10
C2 - Idaho Fescue - Bluebunch Wheatgrass Section	
1. Mountain grasslands	M4
C3 - Cottonwood - Shrub - Bunchgrass Climax	
1. Flood plains	A2
III. Semi-Arid Steppe Lowlands Province	
A. Western Wheatgrass - Needle & Thread - Blue Gamma - Big Sage Section	
1. Alluvial basins	B1
2. Folded sedimentary rock foothills	F2

3. Gravel-capped bench foothills	F3
4. Sedimentary benchload plains	P1 & P5
5. Rolling shale plains	P2 & P6
6. Badlands	P3
7. Glacial deposition plains	P4
8. Moderately dissected sedimentary bench plains	P7 & P8
9. Rolling sandstone plains	P11
B. Rough Fescue - Idaho Fescue - Bluebunch Wheatgrass Section	
1. Alluvial basins	B2
2. Glacial deposition basins	B3
3. Igneous - metamorphic rock foothills	F1
4. Gravel-capped bench foothills	F4
5. Hogback ridge foothills	F5
6. Limestone plateaus	F6
7. Folded sedimentary rock foothills	F7
8. Palouse prairie loess hills	P13
C. Azonal: Topo-Edaphic Climax	
C1 - Ponderosa Pine - Bunchgrass Section	
1. Highly dissected sedimentary benchland	P12
C2 - Cottonwood - Shrub - Bunchgrass Section	
1. Floodplains	A2
IV. Subhumid Prairie Lowland Province	
A. Bluestem - Prairie Sand Reed Section	
1. Choppy sandhills	P9
2. Sandy glacial lake plain	P10

THE LAND

MONTANA PORTION
of
NORTHERN ROCKY MOUNTAIN
PROVINCE ▨



PROVINCE

Definitive Criteria: *Basic Components - Lithology, Structure, Climate-Vegetation*

Delineates *regional differences by topographic patterns and climates as expressed by broad vegetative patterns*

Mapping Scale: *1:1,000,000 or larger*
Size: *1,000 sq. miles*
Use: *Nationwide Data Summary*

COLUMBIA FOREST HIGHLAND PROVINCE

Location: *Northern portion of Rocky Mountain Division*

Geomorphic Processes: *Uplift, Alpine Glaciation, Fluvial*

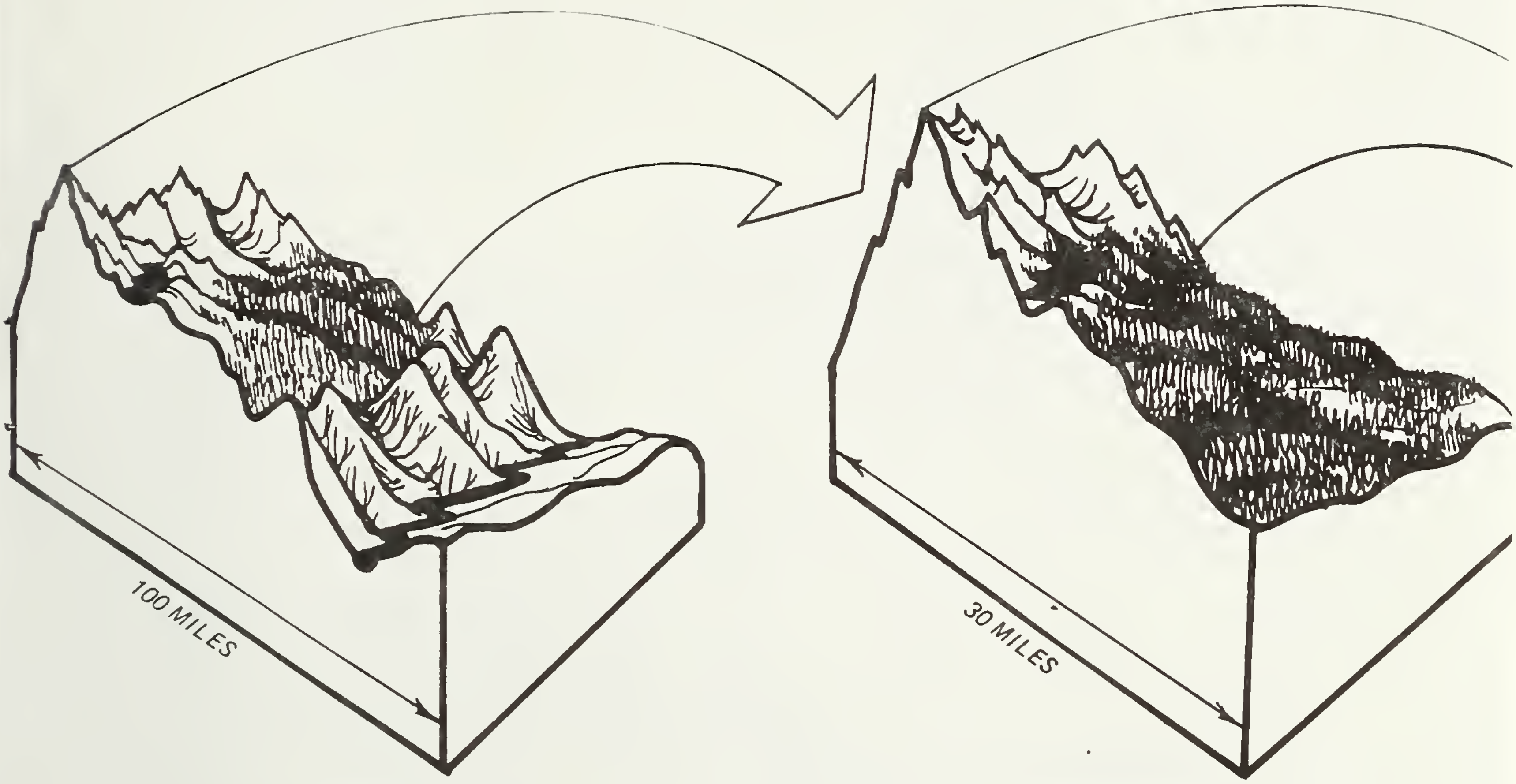
Topography: *Mountains and Intermontane Valleys*

Soils: *Entisols, Inceptisols, Alfisols and Spodosols*

Vegetation: *Coniferous Forest*

Major Qualities: *High water production, timber and habitat for wildlife & fisheries, mining & recreation*

THE



SECTION

Definitive Criteria: Basic Components - Lithology, Structure, Climate-Vegetation

Delineates differences by topographic expression and vegetation, climate, and soil development patterns

Mapping Scale: 1:500,000 - 1:1,000,000
Size: 100's to 1,000 sq. miles
Use: National & Regional Planning & Data Summary

SUBALPINE FIR/DOUGLAS FIR/CEDAR/HEMLOCK SECTION

Location: Northwest portion of the Northern Rocky Mountain Province

Geomorphic Processes: Alpine Glaciation

Topography: High Massive Mountains

Soils: Cryic and Frigid, Entisols and Inceptisols

Vegetation: Alpine Fir and White Bark Pine

Major Qualities: High water production, timber, habitat for wildlife & fisheries, mining & recreation

SUBSECTION

Definitive Criteria; Basic Components - Lithology, Structure, Climate-Vegetation

Delineates major components of sections

Mapping Scale: 1:250,000 - 1:500,000
Size: 25's to 100's sq. miles
Use: Regional & Subregional Planning and Data Summary

CARBONATE BELT ROCK MOUNTAINS SUBSECTION

Location: Swan Mountain Range

Geomorphic Process: Alpine Glaciation and processes resembling Cryoplanation

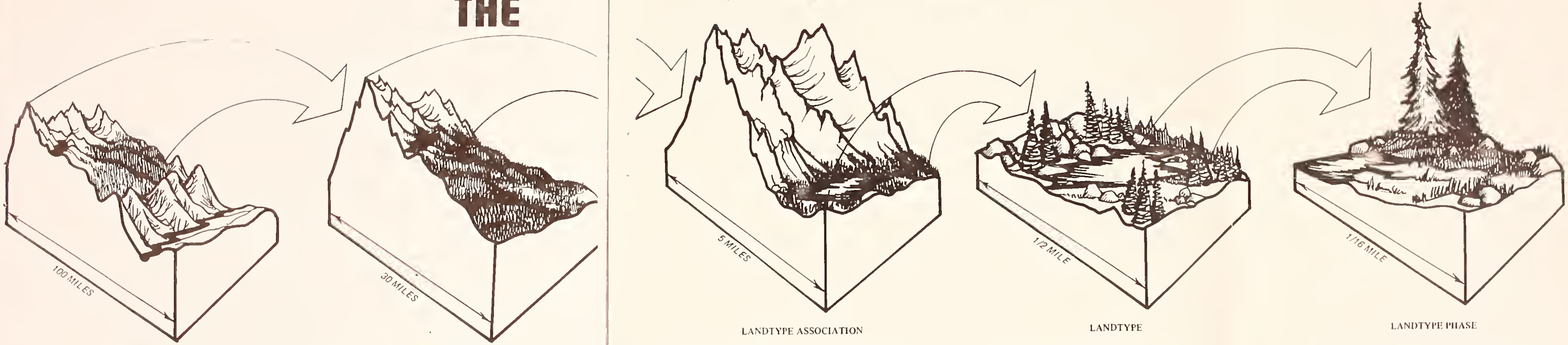
Topography: Rolling uplands and broad smooth valleys

Soils: Andic & Lithic Cryochrepts, Cryorthents & Cryoboralfs and Cryorthods

Vegetation: Subalpine fir series

Major Qualities: High water production, good habitat for wildlife & fisheries, important recreation areas

THE LAND SYSTEM



SECTION

Definitive Criteria: *Basic Components - Lithology, Structure, Climate-Vegetation*

Delineates *differences by topographic expression and vegetation, climate, and soil development patterns*

Mapping Scale: *1:500,000 - 1:1,000,000*
Size: *100's to 1,000 sq. miles*
Use: *National & Regional Planning & Data Summary*

SUBALPINE FIR/DOUGLAS FIR/CEDAR/HEMLOCK SECTION

Location: *Northwest portion of the Northern Rocky Mountain Province*

Geomorphic Processes: *Alpine Glaciation*

Topography: *High Massive Mountains*

Soils: *Cryic and Frigid, Entisols and Inceptisols*

Vegetation: *Alpine Fir and White Bark Pine*

Major Qualities: *High water production, timber, habitat for wildlife & fisheries, mining & recreation*

SUBSECTION

Definitive Criteria; *Basic Components - Lithology, Structure, Climate-Vegetation*

Delineates *major components of sections*

Mapping Scale: *1:250,000 - 1:500,000*
Size: *25's to 100's sq. miles*
Use: *Regional & Subregional Planning and Data Summary*

CARBONATE BELT ROCK MOUNTAINS SUBSECTION

Location: *Swan Mountain Range*

Geomorphic Process: *Alpine Glaciation and processes resembling Cryoplanation*

Topography: *Rolling uplands and broad smooth valleys*

Soils: *Andic & Lithic Cryochrepts, Cryorthents & Cryoboraifs and Cryorthods*

Vegetation: *Subalpine fir series*

Major Qualities: *High water production, good habitat for wildlife & fisheries, important recreation areas*

LANDTYPE ASSOCIATION

Definitive Criteria: *Manifest Components - Assoc. of Habitat Types, Soils, Landform*

Delineates *areas in similar stages of development which reflect hazards and/or capabilities*

Mapping Scale: *1:60,000 - 1:125,000*
Size: *1's to 25's sq. miles*
Use: *Data summary for allocation of resources*

ALPINE GLACIATED HEADLANDS

Location: *High elevation areas*

Geomorphic Processes: *Alpine Glaciation, scour and deposition*

Topography: *Steep rocky peaks, ridges and cirque basins*

Soils: *Lithic & Andic Cryorthents & Cryochrepts of loamy skeletal families*

Vegetation: *Subalpine fir/white bark pine, Subalpine fur/woodrush and Subalpine fir/menziesia habitat types*

Major Qualities: *High water production, recreation & wildlife, aesthetics, timber*

LANDTYPE

Definitive Criteria: *Manifest Components - Soils, Landforms, Habitat Types*

Delineates *the permanent elements of the ecosystem that have predictable behavior patterns*

Mapping Scale: *1:30,000 - 1:60,000*
Size: *1/10 to 2 sq. miles*
Use: *Comprehensive Planning*

CIRQUE BASIN LANDS - LOAMY SKELETAL SOILS

Location: *Head of glaciated valleys*

Geomorphic Processes: *Scouring and deposition of materials by ice*

Topography: *Gently sloping basins*

Soils: *Andic Cryochrepts loamy skeletal mixed, and Typic Cryorthents loamy skeletal mixed*

Vegetation: *Subalpine fir/woodrush and Subalpine fir/menziesia*

Major Qualities: *Water flow regulator, timber, recreation, wildlife, fisheries, aesthetics*

LANDTYPE PHASE

Definitive Criteria: *Manifest Components - Soils, Landforms, Habitat Type Phase*

Delineates *individual components of landtypes*

Mapping Scale: *1:15,000 - 1:30,000*
Scale: *1/100 to 1/10 sq. mile*
Use: *Project Development and Detailed Planning*

TYPIC CRYOCHREPTS LOAMY SKELETAL MIXED

Location: *Depression and nearly level high basins*

Geomorphic Processes: *Deposition by glacial ice*

Topography: *Concave depressions in basins*

Soils: *Andic Cryochrepts & Andic Cryoboralfs, loamy skeletal mixed*

Vegetation: *Subalpine fir/woodrush, Subalpine fir/menziesia*

Major Qualities: *Water flow regulator, timber*
SITE: *Similar to high intensity detailed soil surveys. Provides precise understanding of ecosystem components.*

Adapted from the
Boise National Forest
Land Systems Inventory
Report 1975

SYSTEM

Diagram I is a comparison of the different levels of intensity of land system inventory. This diagram is designed to make relative comparisons and facilitate the understanding of relationships among the various levels of the inventory system.

B. THEORETICAL BASIS

The theoretical basis for land system inventory is that landforms, patterns of soils, and climax plant communities are all products of the interaction of climatic forces with the geologic structure of the earth's surface. This system of classification integrates the sciences of geomorphology, geology, soil science, hydrology and plant ecology to classify, map and describe various kinds of lands.

Landforms, soils and climax plant communities all result from the interactions of climate, lithology and geologic structure; hence, they are strongly interrelated, and the classification of any single component will result in at least a partial classification of the other two.

C. COMPARISON OF THE LAND SYSTEM INVENTORY TO OTHER INVENTORY SYSTEMS

A comparison of land system inventory to other inventory systems is presented in Table I. This table is designed for comparison only, and the intensity of inventory is not necessarily comparable horizontally across the various levels.

1. Habitat Type

Habitat type classification systems integrate the more important environmental factors that affect climax plant communities. The land system inventory differs from vegetative classification in that landform and soil properties, not significant to the establishment of climax plant communities but which are important to other land uses, are described. These land properties may be unrelated or only indirectly related to habitat types. These properties are directly classified in the landtype system.

2. National Cooperative Soil Survey

The National Cooperative Soil Survey system uses taxonomic units, as defined by the Soil Taxonomy, that are based on observable or measurable properties of the soil. The lowest category of classification(4) in the Soil Taxonomy is the Soil Series. An additional category, called Soil Phase, is based upon soil properties significant to land management but which are not definitive within the taxonomy. Soil survey mapping units are defined by soil composition at any level of the Soil Taxonomy and there is a hierarchy of mapping units of varying intensity depending upon the level of information needed (see Table I).

Soil Taxonomy often combines mountain soils that have distinctly different management properties. As the basis for management decisions, Soil Taxonomy is not sensitive enough to variations in climatic factors such as aspect or elevation in mountainous landscapes. This is partly due to the fact that temperature and moisture criteria used in the Soil Taxonomy were designed to separate soils within broad climatic zones and are not refined enough to reflect local climatic differences which may produce native plant communities with distinctly different management properties. Landtype mapping and third order soil surveys (see Table I) can be very similar depending upon how the soil phase is used in the soil survey. However, in landtype surveys, land properties derived from landforms and plant ecology are measured because they are definitive in the classification system. In soil surveys these properties are not recorded unless the mapper is aware of their importance to land management and sets up appropriate soil phases to portray differences.

Landtype mapping has the additional advantage in timbered mountainous land of facilitating initial photo interpretive mapping of the land. The formation of a hypothesis of how the landscape was formed provides a systematic basis for subsequent photo interpretation of land qualities.

3. Soil Resource Inventories

Soil resource inventories are made either at Level III or Level IV; thus, the soils data collected at the landtype mapping level is similar to that collected in a Soil Resource Inventory. The soil resource inventory is made to provide some basic soil, bedrock and landform information for management interpretations. It primarily is referred to as a "planning grade inventory." Through this process, soils, landforms and bedrock characteristics are defined at an intensity sufficient enough to be useful in the development of basic resource management plans. However, due to the reconnaissance nature of this survey, it does not provide enough detail for use in high-intensity or small-area planning projects. Soil profile characteristics are described in terms of litter layer, surface layer and subsoil layer. The Soil Resource Inventory is designed to inventory large areas of land in a relatively short period of time.

4. Geologic Inventories (Lithology and Structure)

Geologic inventories concentrate on lithology and geologic structure as they exist on the land. These features are significant to management and included in the landtype inventories as accessory characteristics associated with landform. A landtype inventory, however, is broader in scope and includes vegetative features and soils within the basic inventory structure. Geologic detail that does not significantly influence management is not included.

SUMMARY

Extensive areas of National Forest land in Region 1 have already been inventoried at the landtype level. Experience in Region 1 has demonstrated that an analysis of the inferred geomorphic history of landscapes and the formation of mapping units based on this analysis as defined in terms of low-order stream features, local relief and slope shapes, produces mapping units with predictable reoccurring patterns of soils and habitat types. This procedure then facilitates the mapping of large areas of land using photo interpretation with a minimum of field checking. Landtype inventories have been an ideal tool for inventorying of land potential in steep, forested, mountainous terrain. They provide a maximum of land information with a minimum of investment. The kind of information produced and its reliability is adequate for most management decisions at the resource allocation level.

TABLE I

COMPARISON OF
THE LAND SYSTEM
INVENTORY TO OTHER
INVENTORY SYSTEMS

CLASSES:

— VEGETATION
— SOILS - NCSS
— GEOLOGIC

BASIS FOR DELINEATION	APPLICATION	MAP SCALE	VEGETATION
Used on National and Regional levels for program planning.	Kuchler's map needs refinements, but it is usable.	1:7,500,000	FORMATION
Used at National and Regional levels for program planning.	Kuchler's map of Regions	1:3,188,000 to 1:7,500,000	REGION
Used at National and Forest levels for program planning.	The 18 series in the coniferous Forest formation. Kuchler's types are not based on the vegetation system used in Region 1.	1:3,108,000 to 1:60,000	SERIES
Used at Forest & District levels for long-range & project planning. Basis for (1) estimates of land productivity for time & forage; (2) silviculture guides; & (3) range condition & trend guides for livestock & wildlife. Productivity information is used in long-range planning.	H.T.S. are mapped by (1) traversing roads & trails & (2) stand examinations for long-range planning, a satisfactory degree of accuracy can be obtained from extrapolations of the data, using aerial photos and contour maps.	1:30,000 to 1:15,840	HABITAT TYPE
Used at District level. Desirable unit for project planning & execution. H.T. information supplements & does not replace information on the age, condition, structure, & composition of existing stand.	Phases in each delineation are made by field examination. Stand examinations can be upgraded to provide a satisfactory map.	May be less than 1 acre, depending on the significance of the implications. 1:15,840	HABITAT TYPE PHASE

BASIS FOR DELINEATION	APPLICATION	MAP SCALE	MAPPING UNITS	SOILS - NCSS
The mapping units in this inventory system are confined in these terms. These must not be construed to mean that the inclusions within a single mapping unit are limited only to the same or similar taxonomic units.				NCSS - National Cooperative Soil Survey
Very broad planning - Regional, Statewide, and river basins planning.	**Phases of Great Group; Sub-orders or Orders ***	**1:500,000 to 1:1,000,000**	**10,000 acres (old explanatory soil surveys)**	5th Order Very Broadly Defined Association.
Broad planning - applicable to multi-count planning, large RC&D, Statewide planning and State planning districts.	**Phases of soil* families; Phases of sub-groups; Phases of great groups**	**1:125,000 to 1:500,000**	**640 to 10,000 acres (broad reconnaissance soil surveys)**	**4th Order Broadly Defined Association.**
General planning - applicable to county or multi-county planning districts, areas of extensive use such as some rangelands, forested lands & arid lands	**Broad phases * of soil series, and Phases of soil families**	**1:31,680 to 1:250,000**	**40 to 640 acres (reconnaissance soil surveys)**	3rd Order Consociations & Associations.
Operational planning for rangeland, woodland, some cropland tracts. Interpretations limited to overall behavior of soil series.	**Association of* phases of soil series**	**1:20,000 to 1:63,560**	**5 to 40 acres (low intensity detailed soil survey)**	2nd Order Narrowly Defined Associations.
Intensive planning such as predicting specific uses and treatment of discrete tracts of land for agriculture uses.	**Phases of * soil series**	**1:7,920 to 1:31,680**	**0.5 to 10 acres (high intensity detailed soil surveys)**	**1st Order Consociations or Complexes.**

				GEOLOGIC
SAME AS LAND SYSTEMS				PHYSIOGRAPHIC PROVINCE
				SECTION (Sub Province)
				SUBSECTION

INDEPENDENT COMPONENTS LITHOLOGY - GEOLOGIC STRUCTURE - CLIMATE	BASIS FOR DELINEATION	APPLICATION	MAP SCALE	MAPPING UNITS	
	Background for planning and setting priorities 1:60,000 B & W	Literature review Air photo interpretation 1:60,000 B & W	1:63,000 (Limits of error + 3/4 mile)	40 acres or less	GEOLOGIC OVERVIEW
	Allocation of resource's use for Level II Planning	Air photo interpretation on 1:60,000 B & W photos traverse on ¼ to ½ mile, 4 to 6 square miles per day)	1:30,000 to 1:24,000 + ½ mile error units	20 or less acres/unit	GEOLOGIC RECONNAISSANCE
	Locations of developments and facilities. Timber sale areas and EAR reports.	Complete literature review- Air photo interpretation on 1:15,840 B&W+1.R. Traverse on .51 to 1.0 mi. (2-4 mi./day)	1:30,000 to 1:15,840 + ¼ mile error units	10 or less acres	GEOLOGIC SURVEYS
	Design developments and facilities.	Complete literature review - Air photo interpretation on 1:15,840 B&W 1.R. Traverse 1.0 mile (½ to 2 linear mi./ day, or 1 to 5 days/site)	1:15,840 to 1 inch =	40 feet	GEOLOGIC INVESTIGATION PROJECT

EXAMPLES			LEVELS					
			BASIS FOR DELINEATION	APPLICATION	MAP SCALE	MAPPING UNITS	LAND SYSTEM	LEVEL
Physiographic Divisions Classes of Land Surface Form - E. H. Hemmond SCS-LRP Fenneman River Basin Studies	INDEPENDENT COMPONENTS	LITHOLOGY - CLIMATE GEOLOGIC STRUCTURE	Basic Elements Structure, Lithology, Climate.	Nationwide or Broad Regional Data Summary	1:1,000,000	1,000's sq. miles	PHYSIOGRAPHIC PROVINCE	VII
Regional Physiographic of Related Soil Landscape SCS—Land Resource Areas SCS--Land Resource Regions			Basic Elements Structure, Lithology, Climate.	Broad Regional Summary Basic Geologic, Climatic, Vegetative Data for design of individual resource inventories.	1:500,000	100's to 1,000's sq. miles	SECTION (Sub Province)	VI
Western Montana Subsection Map			Basic Elements Structure, Lithology, Climate.	Strategic Management Direction, Broad Area Planning.	1:500,000 to 1:250,000	10's to 100's sq. miles	SUBSECTION	V
	DEPENDENT COMPONENTS	LANDFORM - SOILS - VEGETATION	Manifest Elements Soils, Landform, Biosphere	Summary of Resource Information and Resource Allocation	1:125,000 to 1:60,000	640 to 6,400 acres	LANDTYPE ASSOCIATION	IV
			Manifest Elements Soils, Landform, Biosphere	Comprehensive Planning, Resource Plans Development Standards Local Zoning.	1:60,000 to 1:32,000	64 to 640 acres	LANDTYPE	III
			Manifest Elements Soils, Landform, Biosphere	Project Development Plans	1:32,000 to 1:15,840	5 to 65 acres	LANDTYPE PHASE	II
			Represents integration of all environmental elements. Units are generally not delineated on map.	Provides precise understanding of Ecosystems. Sampling for research, and for detailed onsite project.	Usually not delineated.	Less than one acre	PROJECT INVESTIGATION	I

PART II

THE LANDTYPE

THE LANDTYPE

Introduction

The landtype level of the land system inventory is most commonly used for National Forest planning purposes. Consequently, it is the only level in which the definition of mapping units has been accomplished for lands in the Northern Region. Following is a general discussion of the procedures used to define, map and interpret landtypes. More specific instructions may be found in the Guides and Classification Standards Section.

DIAGNOSTIC COMPONENTS OF THE LANDTYPE

The following properties of landtypes have defined ranges of characteristics and are described and recorded for each landtype unit.

Landform

Identification of the landform component is done first because it is most easily delineated through aerial photo interpretation.

The classification of landform by the inferred dominant process forces the classifier to form a hypothesis of how the landscape was formed. Having classified landforms by photo interpretation, the mapper devises field traverses which cross representative areas of each mapping unit. Patterns of soils and climax vegetation within each representative delineation are then described. If the hypothesis of landform formation is correct, recurring patterns of soils and climax plant communities will be found. Once described and established, these patterns and the associated landform classification become a map of soil and climax vegetation which is called a landtype. This process enables the mapping of fairly large areas of land and permits intensive study of representative areas. Widely scattered spot checks are used to confirm relationships of soil, vegetation and landform that define landtype.

Stream features and patterns as well as local relief and slope shapes are the criteria used to separate a landscape into landform units. Landform classification units are named according to the dominant geomorphic process presumed to be responsible for shaping them. Processes such as glaciation, freezing and thawing, and water or gravitational erosion are, or have been, important in shaping landscapes in the Northern Rockies.

Soils

Soils are normally classified at the family level of the Soil Taxonomy of the National Cooperative Soil Survey. A single landtype must contain a predictable pattern of soils. Representative soil profiles are described using procedures established in the Soil Survey Manual.

At the family level, soil properties are narrowly defined and the most important ones are classified according to soil depth, texture, reaction, etc.(10)

Habitat Types

Climax plant communities are classified using the habitat type system. A single landtype must contain habitat types with similar management properties in a predictable pattern of occurrence.

The habitat type component of the landtype is often the most sensitive to minor climatic variations such as occur with the differences in elevation, slope and aspect as found in mountainous terrain. It is also the most sensitive indicator of the present environment. Climax plant communities adjust rapidly to changing climatic conditions, while landforms and soils often reflect past climatic conditions.

ACCESSORY COMPONENTS OF THE LANDTYPE

Lithology and Structure

Bedrock properties are described to the extent necessary to account for their influences on landforms, usually hardness and structure. The action of landforming processes on bedrock is influenced by inherent properties, such as resistance to erosion and permeability to water. Land area subject to the same geomorphic processes may have variations in landform due to underlying bedrock properties. These landforms are referred to as structurally controlled.

A second major reason bedrock affects landtype classification is that weathering products of bedrock become parent materials for the formation of soil. Physical and chemical properties of bedrock are thus often reflected in the soil.

Bedrocks are usually grouped according to their physical and chemical properties. Typical groups might be igneous, sedimentary or metamorphic rocks, all of varying hardnesses. These would include granites, basalts, siltstones, mudstones, claystones, limestones, etc. Geologic formations can be named if geologic mapping is available or a geologist can participate in the landtype mapping.

Climate

Climatic properties are based on existing weather records. They are estimated through use of data from the nearest weather stations and modified for slope, elevation and aspect considerations.

Climatic factors which may be recorded for landtype include:

1. Average annual precipitation.
2. Percentage of precipitation falling as snow.
3. Fifteen-minute maximum storm intensity.
4. Average annual air temperature.
5. Periods of soil moisture stress.
6. Potential evapotranspiration.

INTERPRETATIONS OF LANDTYPES

Landtypes are units of land with fairly uniform properties. A land manager can apply experience or research results from one landtype to another with a high degree of confidence. Since landtypes are identificable by visible surface features, users of landtype maps can easily identify areas of similar landtypes once their identifying characteristics are known.

Present interpretations for landtypes are based on empirical data and experience. They are qualitative rather than quantitative in nature. As more research becomes available for landtypes, it will become possible to make quantitative ratings. The following interpretations of landtypes are most often requested by Forest Service land managers.

Soil Erosion

Erosion hazard ratings are based on soil properties, climatic factors and landform characteristics. Erosion hazards are given for erosional processes which most frequently occur in mountainous land; that is, water erosion, dry soil creep and mass soil movement. Hazards are presently given in qualitative classes such as low, moderate and severe, and are defined in terms of the limitations imposed on common Forest management practices.

Systems for quantifying soil losses resulting from common Forest land management practices are being developed.

Productivity of Landtypes

Ratings for timber, browse and forage productivity are based on habitat types and soil characteristics. Relative ratings of either three or five classes are assigned based on the ranking of lands within the Region.

Quantitative ratings are being developed as clipping plots, and timber cruise plots are taken within identified habitat types and landtypes.

Hydrologic Behavior

Landtypes, or combinations of landtypes, can function as hydrologic response units. Runoff timing, water yield and the capacity of the land to store and transport precipitation are functions of landforms, soil and climatic factors and are defined in the landtype.

Operability -- Roads & Equipment

Various limitations to travel or road construction or travel across the land surface are recorded. These include slope, rock outcrops, surface stoniness and wet soils.

SUMMARY

Both land systems and separate resource inventories have been made in the Region. The separate resource inventories, most commonly soils, habitat type, and geology, comprise most of the components used in a landtype inventory. Later attempts to integrate the separate resource inventories (made at various mapping intensities for specific onsite resource use) into one map and report has resulted in serious problems, such as; mapping boundary delineations, wide array in the specificity of data, and kinds of interpretations.

The landtype classification procedure evaluates the various components in the field and integrates them into one map. This is best accomplished with a multidiscipline team of specialists involved in defining the landtype units to achieve the desired level of technical accuracy. It is recognized that separate inventories of soils, geology, or habitat types may be appropriate for specific objectives where total land potential or capability is not the goal.

PART III

GUIDES AND CLASSIFICATION STANDARDS

FOR REGION 1 LANDTYPES

GUIDES AND CLASSIFICATION STANDARDS
FOR REGION 1 LANDTYPES

The land base is fundamental to implementation of any land management scheme. There are several land system inventory procedures. The land system inventory incorporates features of surveys currently existing in a variety of specialties. These include geology, plant ecology, soil science, hydrology and climatology. Visual interpretation of integrated effects of processes having an influence on surficial land features results in a land system inventory when represented on some form of map. The system of classification of surficial features, or processes inferred from these features, results in a hierarchical mapping unit classification which organizes in a logical and understandable manner criteria used in delineating mapping units. These guides and classification standards are designed to serve as a base upon which practical field mapping units may be defined for use as one of several fundamental tools available to land managers.

DIFFERENTIATING CHARACTERISTICS

Properties of soil, climax plant communities and landform are differentiated at the landtype level. Properties of climate and bedrock are accessory.

Guides for landform differentiation are necessarily lengthy because of lack of an accepted taxonomic system for landforms at the landtype level of inventory.

Soils

Soils will ordinarily be classified at the family level of the Soil Taxonomy. Landtypes must contain a predictable pattern of soils, each occupying a defined percentage of the area within a landtype. Soils may be classified at higher categorical levels in landtypes in which landform or vegetative properties are of overriding significance to management; for example, flood plains or breaklands.

Soils will be described by major horizons based on readily discernible features and horizons or layers. Horizons will be identified in the terminology of the Soil Survey Manual.(10) Major layers also will be identified by inference of their geologic origin, e.g., loess cap, angular drift, glacial till, etc., as applicable. Inference of geologic origin is strongly recommended on all horizons described. Soil drainage class will be determined following the criteria and nomenclature of the Soil Survey Manual.(10)

Soil horizon characterization will follow the procedures set forth in the Soil Survey Manual, USDA Agricultural Handbook 18.(10) This characterization will include the following items:

- Depth and Thickness
- Consistence
- Structure
- Texture
- Color
- Permeability
- Bulk Density

This list should also include those features that may be unique to the specific mapping area.

Habitat Types

Each landtype must contain a predictable pattern of habitat types; each occupying a defined percentage of the area. Occassionally, landtypes on which landform or soil properties are of overriding significance to management will have the climax plant community defined at the series level or the habitat type component will be left undefined. Terminology will conform to Daubenmire,(5) or Pfister,(9) or Mueggler and Handl.(8) Beyond the range of application of their publications, it is recommended that a local system be devised which relates local habitat types to those defined in these publications.

Landform

The intent of this section is to provide map users with a clear record of observable properties of landforms which the mapper has used to separate lands of differing management qualities so that he may independently evaluate their significance.

The mapper may infer that landforms having significantly different management properties result from different kinds of intensities of geomorphic processes or stage of development. However, these inferences do not constitute documentation of landform properties of landtypes; and, if they are mentioned in this section, it should be clearly stated that they are inferences.

The landform component of landtypes is described for two purposes:

1. To help map users identify landtypes.

2. To document the basis for interpretations in which landform properties are a factor.

Landform properties are one of the more important criteria used to define mapping units in landtype surveys. Consequently, most mapping unit legends group mapping units according to the geomorphic process presumed to be responsible for shaping the landform. Each landtype mapping unit has a defined range for certain selected landform properties. The use of geomorphic criteria to define mapping units has several advantages in soil surveys of wild lands:

1. It forces the mapper to form a hypothesis of how the landscape was formed. If the hypothesis is correct, it greatly facilitates soil mapping by aerial photo interpretation.

   The requirement that soil scientists study and classify landforms encourages them to study geomorphology and develop an understanding of the geomorphic processes which control the distribution of soils in their survey area.

2. It produces mapping units with fairly uniform interpretive properties. Hydrologic behavior, slope stability, and sediment pollution hazards resulting from soil erosion are important interpretations for wild land surveys which cannot be made without considering certain landform properties.

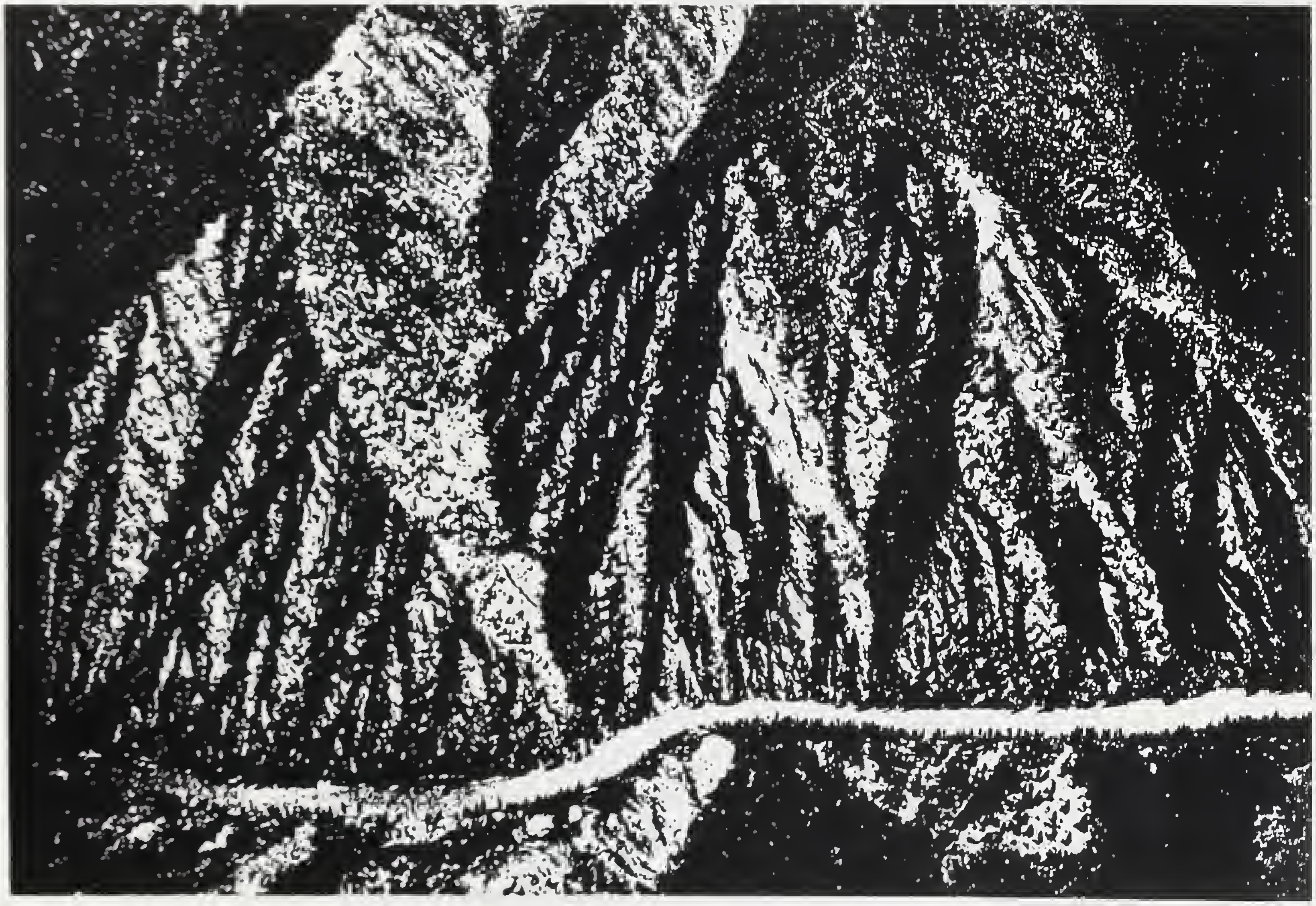
Lack of an accepted landform classification system at the mapping level of landtype surveys has made it necessary to set up local criteria for separating landforms with different management properties. Criteria selected have been empirically determined to be important to management properties of land. Although this local landform classification scheme has received considerable emphasis in Region 1 landtype mapping, it should only be viewed as a tool for aerial photo interpretation of soil and hydrologic properties of land and as a guide for defining landform management criteria.

To achieve greater uniformity in using landform criteria as a basis for defining mapping units and to facilitate communication about landform properties, the primary classes of landforms recognized in Region 1 are defined in the following section. In individual survey areas, additional landform, soil, geologic and climax vegetation properties will be used to further subdivide these classes to produce mapping units with the required uniformity in both management properties and soil taxonomic units.

BREAKLANDS

Breaklands consist of oversteepened lands formed by glacial scouring, fault escarpments or rapid stream downcutting. Slopes tend to be at or above the natural angle of repose for the mantle material. Gravitational erosional processes such as dry soil creep and debris avalanches are important in these landforms. Slopes generally exceed 60 percent, but the lower slope limit for breaklands varies depending upon the nature of the mantle material. Rock outcrops and soils developing in very gravelly or stony colluvial material are common features on many breaklands.

Although this group of landforms results from several different geomorphic processes, they are grouped into one major class because they share the common properties of being lands on which gravitational erosion is a dominant process and on which very steep slopes limit management options.



Breaklands - Nezperce N. F.

CLASSES

Classes of breakland landforms are defined on the basis of the primary process responsible for forming them. The surficial features of these landforms are a function of their stage of development and the process which has acted upon them since their formation. The subdivision of these classes based on stage and secondary process is left to individual Forest soil scientists and, consequently, surficial features are not described for breakland classes.

A. Glacial Breaklands

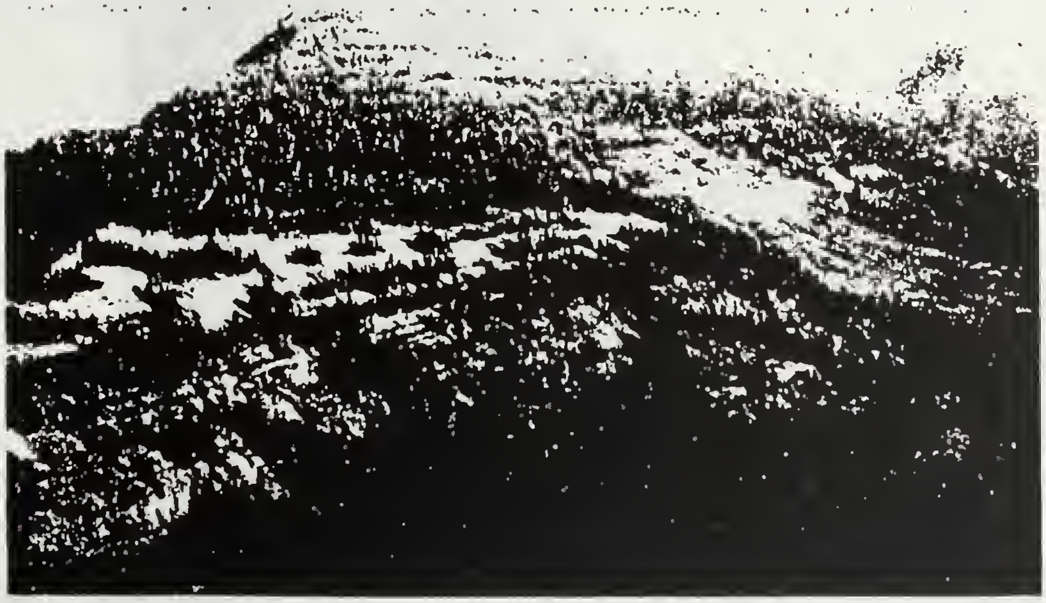
Glacial breaklands are oversteepened slopes produced by glacial scouring. Two major classes are recognized based on the shape of the landforms--glacial cirque headwalls and trough walls or other scoured forms. These classes will all be subdivided at the Forest level based upon a secondary process such as frost churning.

1. Alpine Glacial Cirque Headwalls

Position: These lands occur on north or east-facing slopes at higher elevations and on all aspects at the highest elevations and are associated with cirque basins and small lakes.

2. Glacial Valley Trough Walls & Other Glacially Scoured Breaks

Position: The upper valley slopes along U-shaped glaciated valleys or occasionally mountain peaks which were scoured by local ice cap glaciers is where this class of breaklands is found.



Glacial Scoured Breaklands - Flathead N. F. - Bunker Creek

B. Structural and Stream Breaks

Oversteepened slopes formed by fault escarpments or rapid stream downcutting. Landforms produced by the two processes are very similar and they are separated on the basis of stream breaks always occurring adjacent to major streams. The separation is justified by the rapid delivery of sediment produced by soil erosion on stream breaks to the stream and the greater sediment pollution risk on these landforms. At the Forest level, these landform classes will be further subdivided, based upon stage and a secondary process such as water erosion or one of the classes of frost churning.

1. Stream Breaklands

Position: Always occurs immediately adjacent to a major stream. Stream order jumping is a normal feature of these landforms.

2. Structural Breaks

Postion: May occupy any position except adjacent to a major stream. Stream ordering is usually normal.

Structural Breaklands - Bunker Creek - Flathead N. F. (limestone over argillite bedrock with thick glacial till on flats)

PLUVIAL PROCESS

These landforms are assumed to have been formed primarily by subaerial erosion and are characterized by dense drainage patterns having low stream order spacings of 500-1000 (152-305 meters) with lengths of reach in the low- to mid-100's of feet. They are differentiated from breaklands by occurring on stable slopes, usually less than 60 percent slope, and from weakly frost-churned lands, which frequently occur at higher elevations, by the density of low-order drainage features.

Position: These landforms are located on lower elevation mountain slopes and foothills.

Surficial Features: Topography is generally sharp and angular. Minor amounts of rock outcrop occur on many landforms.

Regolith Properties: Both chemical and physical weathering occur. On older stages of development, chemical weathering may predominate. On the more common youthful stages, the regolith is generally shallow and soil development is minimal.

Basis for Local Subdivisions: Only one class of pluvial lands is defined based on low-order drainage density. In local areas, further subdivisions of the class may be based on stage of development as inferred from degree of dissection by low-order streams, the degree of chemical weathering in the regolith, or secondary process.

COLLUVIAL PROCESS

These depositional landforms have been formed primarily by transport of soil and rock material by gravity and dry soil creep. The transported material is mostly a product of intense mechanical weathering.

CLASSES

Two classes are recognized--mixed soil and rock debris (colluvium) and rock rubble (talus & scree).

A. Colluvium

Position: This class is associated with breaklands and occurs at the bases of slopes where the angle of surface is rapidly reduced to meet valley bottoms. Includes depositional debris at bases of snow chutes.

Surface Features: Smooth to slightly concave surface; slopes typically are steep; conical shapes are typical.

Regolith: Unconsolidated soil and rock debris. Consists of heterogeneous materials of any particle size.

Differentiating Criteria: Separated from alluvial-colluvial fans by angularity of coarse fragments and lack of distinctive stratification and typically steeper slopes. Separated from talus and scree by containing sufficient soil size particles to support vegetation.

B. Talus & Scree

Position: Closely associated with rock outcroppings on breaklands and toeslopes of breaklands.

Pioneer vegetation on talus slide (colluvial) below glacial scoured breaklands - Flathead N. F.

Surface Features: Very steep, straight to slightly concave slopes; generally a sheet of coarse debris mantling the lower one-third of a mountain slope below rock outcroppings, or cones at base of breaklands; slopes generally greater than 65 percent.

Regolith: Generally thick mass of angular, loose rock lying at or near the angle of repose. Generally not vegetated or only sparsely vegetated.

Differentiating Criteria: Separated from alluvial-colluvial by consisting mostly of coarse, angular rock material deposited by gravity.

FLUVIAL PROCESS

These depositional landforms have been formed primarily by transport of soil or rock material by water. They are typically associated with channel flow.

CLASSES

The surficial features of these landforms are a function of primary process responsible for their formation. Subclasses may be differentiated on soil texture, drainage, etc. Subdivision of classes is left up to the Forest soil scientist.

A. Alluvial-Colluvial Fans

Position: Associated with intermittent streams emerging from steep topography and accumulating on lower slopes and/or at the bottom of the steep slopes.

Surface Features: Low relief forms with characteristic delta shape. The apex of the delta points to the source of the material.

Regolith: Stratified sediments, usually skeletal, with subrounded to rounded coarse fragments. Thick unconsolidated sediments more than six feet thick.

Differentiating Criteria: Separated from terraces by surface configurations parallel with major streams. Separated from pediments by having thicker mantles. Distinguished from avalanche debris in having subrounded or rounded coarse fragments and typically at lower elevations not associated with glaciation and/or high snowpack areas.

B. Pediments

Position: Usually adjacent to steep uplands in a semiarid or arid climate.

Regolith: Normally skeletal material containing free calcium carbonate. Regolith thickness varies considerably, but normally is less than six feet thick.

Differentiating Criteria: Separated from alluvial fans and stream terraces by having a shallower regolith and a plane slope shape.

C. Terraces

Position: Associated with streams but above the level of flooding and fluctuating ground water.

Surface Features: Low relief forms associated with major streams. Typically with short, steep breaks along streams or confluence with flood plains.

Regolith: Stratified sediment with rounded, coarse fragments. Thick, unconsolidated mantles.

Differentiating Criteria: Separated from flood plains by their lack of shallow, fluctuating water tables, flood hazards and meandering streams. Typically distinguished from lacustrine by having coarser textured, highly stratified regolith, absence of varves and close association with major streams.

D. Flood Plains

Position: Flood plains associated with streams.

Surface Features: Low relief forms associated with stream channels containing old meander scars and supporting riparian vegetation.

Regolith: Stratified sediments with rounded, coarse fragments. Fluctuating ground water, thick unconsolidated mantles and floods of undetermined frequency.

Differentiating Criteria: Immediately adjacent to major streams with fluctuating ground water, and occasional flooding separates these lands from all other fluvial lands.

E. Glacial Outwash

These are landforms developed in stratified sand, gravel and cobble-sized rocks. Outwash plains and valley trains are two landforms recognized.

Outwash Plains: Occur on stream terraces and are gently sloping to level outwash plains.

Valley Trains: Occur on sloping convex-shaped fans in front of valley glaciers. Long, narrow body of outwash deposited by melt waters and confined within the walls of a valley beyond the terminal moraine.

MASS WASTING PROCESS

These landforms are produced by gravitational movement of soil or rock in mass. They are characteristically benchy or hummocky with broken slopes. In earlier stages of development they lack an integrated drainage system; contain undrained potholes, seeps, springs, and raw, unvegetated slip scars.

Mass wasting - Gallatin N. F.

CLASSES

Two major classes are recognized based upon the degree of consolidation of the material moved. Both classes will commonly need to be subdivided at the Forest level on the basis of stage of development as inferred from the degree of dissection by low-order streams.

A. Geologic

Landform produced by mass movement of consolidated bedrock. Usually associated with resistant rocks overlying weakly consolidated rock. The landforms contain glide blocks of resistant rock underlain by softer rock.

Surficial Features: Hummocky, benchy slopes, on landforms of low relief. Low-order streams are either absent or, if present, very weakly entrenched.

Regolith Properties: Generally thick regolith containing slowly permeable layers and concentrations of ground water. Variable amounts of angular boulder to gravel-sized coarse fragments.

B. Mantle Failures

Landforms produced by rotational slumping or mudflows.

Surficial Features: Benchy or hummocky slopes on low-relief landforms. Either no low-order drainage features or a dense pattern of weakly entrenched low-order drainage.

Regolith Properties: Regoliths containing slowly permeable layers and concentrations of ground water. Generally lacking the boulder-sized glide blocks of hard rock found in geologic mass-wasted forms.

FROST CHURNING PROCESS

Frost churning is a process whereby frost-riven rock and fine earth are transported downslope by frost action and gravity. This process produces a mantle of slowly moving frost-riven rock which tends to reduce topographic features to a common level, eliminate drainage waste and reduce slope gradients.

CLASSES

A. Weak Frost Churning

Position: The position of these landscapes is highly variable. They normally occur on ridges and slopes adjacent to pluvial or breakland landscapes and lands exhibiting moderate frost churning.

Surficial Features: Slopes within the landscape tend to be straight to slightly convex with subdued local topography. First to third order streams may occur, but first order streams dominate. Stream dissections are weak to moderate with spacings in the low to mid-hundreds of meters (high hundreds to low thousands of feet) and reaches in low hundreds of meters (high hundreds of feet).

Regolith Properties: Chemical and physical weathering processes seem to be of equal importance, and regolith depth is variable depending on stage of development of the landscape. Mesic and frigid temperature regimes predominate, and coarse fragment content is dependent on bedrock type.

Differentiating Characteristics: The differentiating characteristics of these landscapes from those adjacent are the low-order (up to and including third order) stream densities and lengths of reach. Additional characteristics are important in differentiating this landform from landforms with primary landforming processes other than frost churning.

Drainages in pluvial landscapes tend to be more numerous when compared with the gently convex drainages in weakly frost-churned lands. There is often a break in drainage density and slope shape in going from frost-churned to pluvial landforms. Pluvial processes tend to produce steeper, more concave slopes, and denser drainage patterns with low-order stream reaches on the order of tens of meters rather than hundreds. Breaklands are differentiated by the appearance of oversteepened slopes and breaks in the ordering of streams at the base of this landform.

B. Moderate Frost Churning

Position: The position of these landscapes is variable. They typically occur on ridges and slopes and are associated with other classes of frost-churned lands, pluvial lands and breaklands.

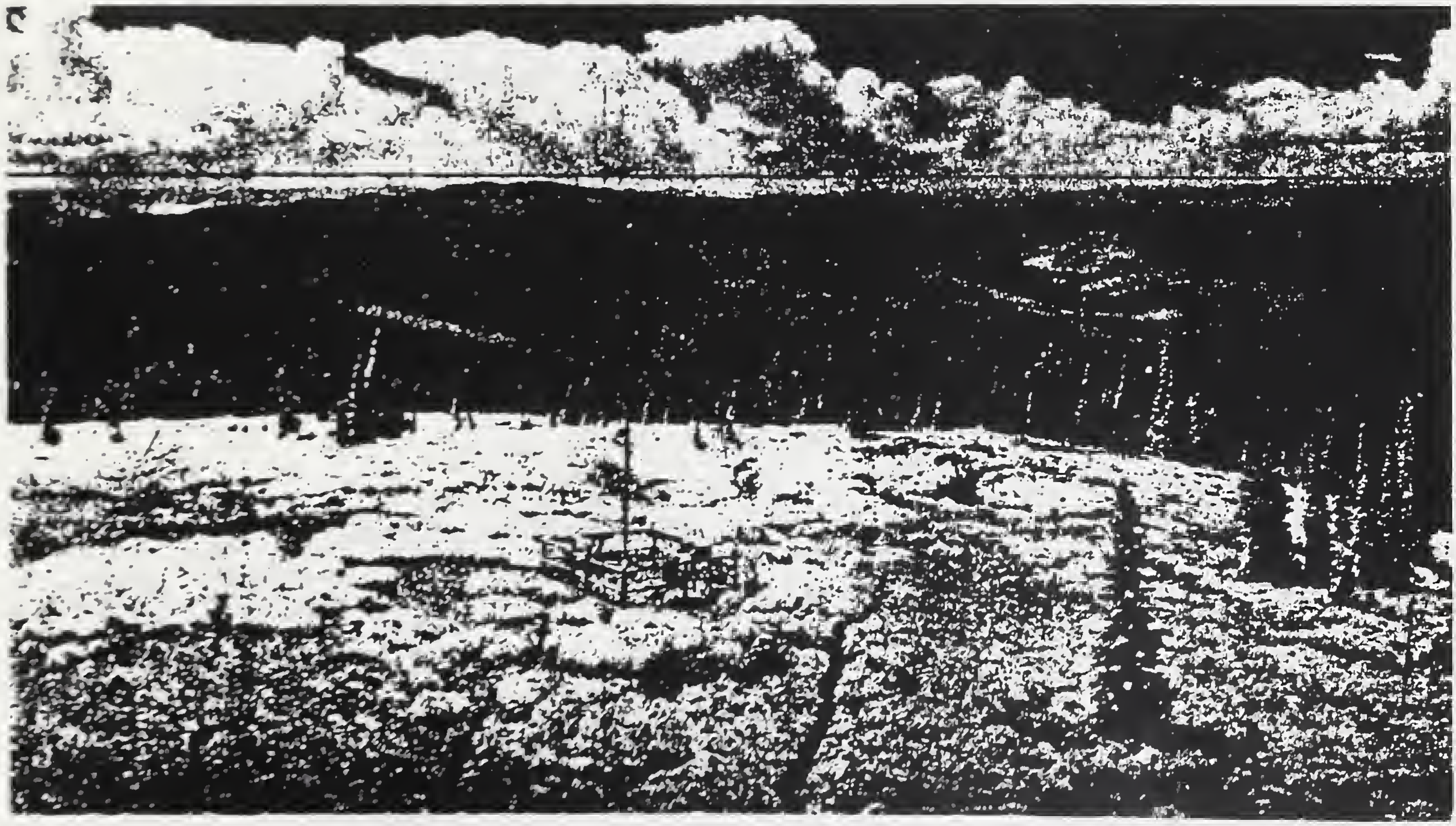
Surficial Features: Slopes within this landscape tend to be straight to slightly convex with subdued local topography. First to third order streams may occur but first order streams are dominant. Stream dissections are weak with spacings in the mid-hundreds to low thousands of meters (low to mid-thousands of feet) and reaches in the mid-hundreds of meters (low thousands of feet).

Regolith Properties: Physical weathering is the dominant decomposition process with moderate chemical weathering. Mantles are generally thick and skeletal with cryic (cold) temperature regimes. Some types of bedrock do not exhibit high coarse fragment contents under these conditions. Generally, however underlying strata are highly fractured and the boundary between rock and soil is difficult to define.

Differentiating Characteristics: Low-order stream densities and lengths of reach are the differentiating characteristics of these landscapes from adjacent landscapes. They are differentiated from pluvial lands and breaklands on the same basis as are weakly frost-churned lands.

C. Strong Frost Churning

Position: These landscapes occur on high elevation ridges and upper valley slopes. They are associated with other units showing frost churning and glaciated lands.



Frost Churning - Green Mountain Area - Nezperce N. F.

Surficial Features: These landscapes tend to have straight to convex slopes with broad rounded ridgetops and subdued local topography. There is a general lack of dissection and entrenchment by streams. Where dissections exist they tend to occur at the lower elevation margins of the landform.

Stream spacings are in low thousands of meters (mid-thousands of feet) with reaches in mid to high hundreds of meters (low thousands of feet) where reaches do not exceed the lower boundary of the landform.

Regolith Properties: Physical weathering is the dominant decomposition process with little chemical weathering. Mantles are generally thick and skeletal with cryic (cold) temperature regimes. Some types of bedrock do not exhibit high coarse fragment contents under these conditions. Generally, however, underlying strata are highly fractured and the boundary between rock and soil is difficult to define.

Differentiating Characteristics: The differentiating characteristics of these landforms from those adjacent are the low-order stream densities, entrenchments and reaches. Local characteristics for differentiation are variable and generally serve to separate this landform from glaciated areas.

D. Patterned Ground (see photograph on page 28)

Position: These landscapes occur above timberline on high elevation unglaciated ridges.

Regolith Properties: Regolith properties are highly variable and dependent on bedrock properties. Generally, however, there are significant areas of lithic soils with pergelic temperature regimes.

Differentiating Characteristics: The differentiating characteristics of these landforms are the presence of alpine grassland at or near topographic high points and the appearance of patterned ground features.

E. Solifluction Deposits

Position: Basins at drainage heads and valley toeslopes associated with frost-churned landscapes. Although these deposits probably occur in glaciated landscapes, they are not consistently separable from glacial deposition.

Surficial Features: Straight to weakly concave slopes, either undissected by low-order streams or very weakly dissected. Often with a hummocky surface microrelief.

Regolith Properties: Physical weathering is the dominant decomposition process with little chemical weathering. Mantles are generally thick and skeletal with cryic temperature regimes. Mantle characteristics are identical to those produced by strong frost-churning and differ only by having been transported far enough that these deposits may overlie bedrock unlike that from which the mantle is formed.

Differentiating Characteristics: Separated from frost-churned landforms by mantles weathered from bedrock other than that now underlying the mantle. Where the underlying bedrock has a lower permeability rate than that from which the mantle weathered, seeps and springs are common features. Many landforms have a hummocky surface microrelief-like glacial drift, but contain angular instead of rounded coarse fragments.

F. Nivational Basins

Position: Shallow, concave basins at drainage heads and on the lee sides of low ridges below the lower elevational limits of glaciation. Dominantly with northeast or north aspects. Often occur in weakly to moderately frost-churned landscapes. Seeps and springs, or a wetter moisture regime than adjacent slopes, are typical. These shallow basins intergrade to very weakly developed glacial cirques. Where developed in soft sedimentary rocks, they intergrade to shallow landflows.

Surficial Features: Gentle to moderately steep, concave slopes with weak, very shallow dissection by low-order streams. Slopes are characteristically smooth with very little microrelief, except where secondary mass wasting has occurred.

Regolith Properties: Mantles are typically layered, with a thin (less than one meter) physically and chemically altered surface deposit overlying weathered bedrock, usually of the same lithology. Rock fragments, where present, are angular. Overall regolith properties are most similar to those found under weak frost-churning depending on the bedrock.

Differentiating Characteristics: The characteristic "spoon-shaped" depression in a landscape position favorable to snow accumulation is diagnostic. The absence of a headwall or moraine differentiates nivational basins from weakly developed glacial cirques. Mantles are thinner than those of solifluction deposits, have been transported shorter distances, and are derived from the underlying bedrock. Mass-wasting, if present, has not caused the deeper, continuous movement of material typical of landflows.

Figure I - Expression of accessory characteristics used to differentiate some landforms within frost-churning assocation.

Strength of Expression	Stream Spacing	Stream Reach Length	Stream Entrenchment
Weak	Low to mid hundreds (m)	Low hundreds (m)	Moderate to Weak
Moderate	Mid hundreds to low thousands (m)	Mid hundreds (m)	Weak
Strong	Low thousands (m)	Mid to high hundreds (m)	Weak to absent
Patterned* ground	---	---	Absent

***Also exhibits rock patterns (rock nets, rock garlands, rock stripes) in an alpine setting.**

Patterned Vegetation on Limestone
Bow Mountain - Flathead N. F.

GLACIATION PROCESS

I. Deposition

Lands with low relief on moderate to gentle slopes with a range of material sizes from a single or mixed lithology. The coarse fragment content will be rounded or subrounded and may be mixed or unlike the underlying bedrock.

Landforms resulting from deposition by glacial ice include the following: ground, lateral and terminal moraine, drumlins, crevices, eskers, kames and kettles. Valley trains, outwash plains, and lake basins are associated with melt water and are described in fluvial and lacustrine processes.

Elk Creek - Mission Mountains - Flathead N. F.

22 - THIN FIRM GLACIAL TILL
26 - THICK FIRM GLACIAL TILL
57 - FROST-CHURNED, GLACIAL SCOURED LANDS
71 &
72 - ALPINE GLACIAL BREAKLANDS
73-- TROUGH WALL - GLACIAL BREAKLANDS

CLASSES

A. Thin Deposition

This class is characterized by a thin veneer, usually less than two meters, of glacial deposits with the surface topography controlled by underlying bedrock.

Drainage pattern often reflects bedrock structure or firmness of the till. This class includes areas with less than 50 percent scoured bedrock or rock outcrops. Scoured bedrock inclusions may exhibit various stages of frost churning as a secondary process. Two subclasses are recognized - firm and friable.

1. Firm Deposition

Thin, firm glacial deposits are characterized by dense, shallow, parallel, low-order drainage patterns. Slopes are usually over 30 percent.

2. Friable Deposition

Thin, friable deposits characterized by moderately incised, structurally controlled drainage patterns with first, second and third order streams. Slopes are usually less than 60 percent on morainal landforms.

B. Thick Deposition

This class is characterized by a thick deposit of glacial debris with a surface topography that is unrelated to the underlying bedrock. The drainage pattern is dendritic and reflects permeability, texture and thickness of the deposits. Two subclasses are recognized--landforms that have originated from poorly sorted materials and landforms that have originated from well sorted materials.

(See photograph on following page.)

Thick, friable glacial till in foreground with "U"-shaped glaciated valley (trough wall) in background.
Bunker Creek - Flathead N. F.

1. Poorly Sorted

These are landforms developed in homogeneous glacial debris. The drainage pattern is dendritic and incisement is related to permeability with density reflecting slope and size of watershed. Slopes are usually less than 60 percent. Small inclusions of well-sorted outwash or lacustrine deposits may occur as fans or in small basins. Two types are recognized -- homogeneous glacial till and glacial fluvial deposits (which are glacial tills whose several feet of surface depth have been altered by some degree of water sorting).

a. Glacial Till - occurs in basins and valley bottoms as morainal features. Slopes are smooth to rounded with gentle relief having a dendritic and/or parallel drainage pattern. Two subclasses are recognized - firm and friable.

(1) Firm - thick glacial deposits characterized by a parallel drainage pattern.

Thick, firm glacial till soils with concentrated subsurface water - Flathead N. F.

(2) Friable - thick glacial deposits characterized by a dendritic drainage pattern.

b. Reworked Till - occurs in valley bottoms as a glacial till whose several feet of surface depth have been altered by water sorting (two-storied till). These are friable.

2. Well Sorted

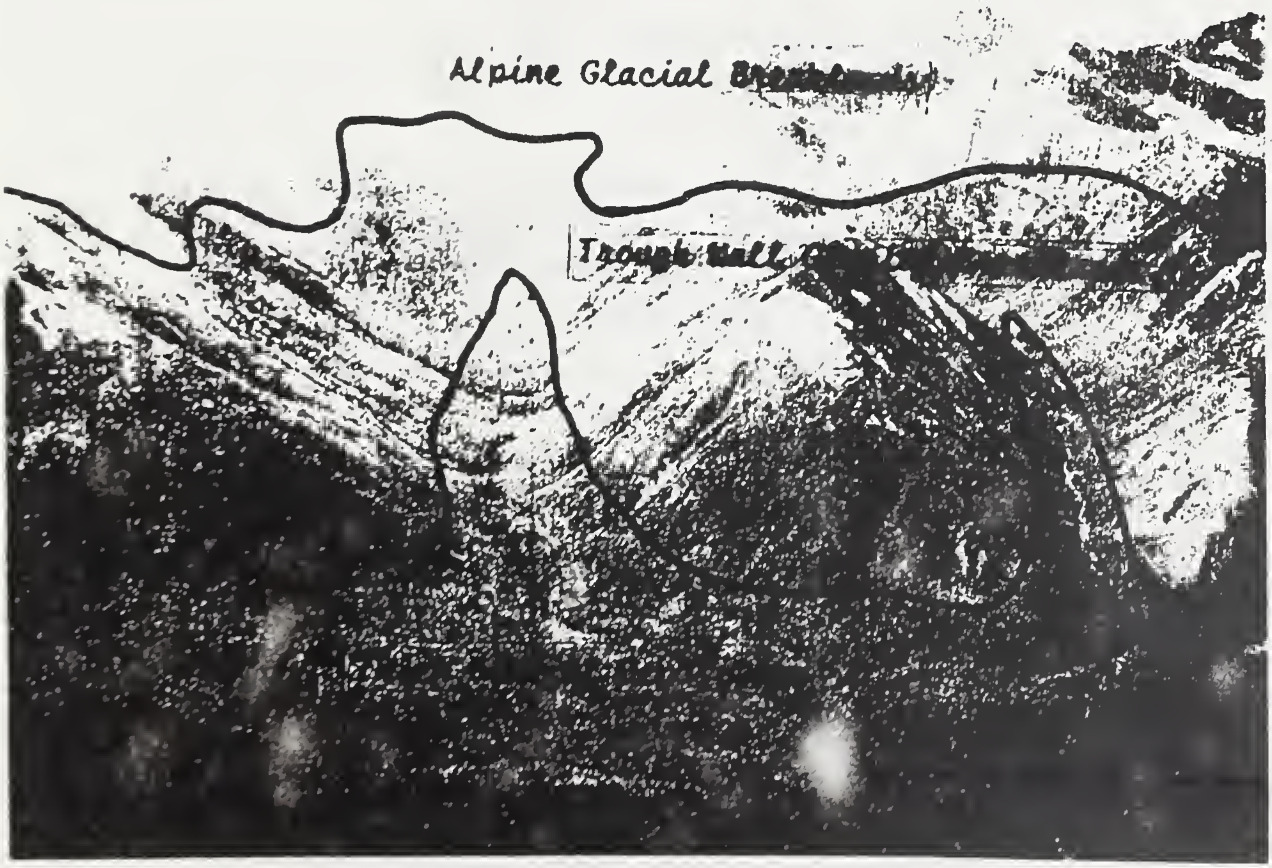
These landforms are developed in glacial debris sorted by water. The drainage pattern is dendritic, and incisement is related to permeability of the material. Glacial outwash has a widely spaced drainage pattern. Lacustrine deposits have a dense drainage pattern. Slopes are nearly level to gently sloping and seldom exceed 20 percent. Two types, outwash and lacustrine, are recognized (see fluvial and lacustrine section for further breakdown).

II. Erosional Glacial Landforms

Lands with low relief, on moderate to very steep slopes, resulting from glacial scouring. Slopes are broken down into two classes. Glacial breaklands usually occur on slopes more than 60 percent. Other glacial slopes occur at less than 60 percent, depending upon the nature of the mantle material. Geologic structure or bedrock attitude may have determined the degree of glacial scour, thus having an effect on the amount of slab rock to rock outcrop. Convex to rounded scoured ridgetops are the result of scouring by continental ice. Cirque headwalls and upper trough walls are the result of scouring by alpine and valley ice. Macro drainage patterns reflect the permeability of bedrock structure and bedrock joint patterns. Micro drainage patterns (first and second orders) reflect structure and the effect of the secondary landforming process on the land surface.

A. Glacial Breaklands

These are oversteepened lands formed by glacial scouring. Slopes are at or above the natural angle of repose for the mantle material. Slopes are generally in excess of 50 percent. Two stages are recognized - early and late. The early stage has more than 50 percent of the area in rockland. The late stage has less than 50 percent of the area in rockland. (See Breaklands for further discussion of landforms.)



Glacial Breaklands - Deep Creek - Kootenai N. F.

3. Other Glacial Slopes

These are lands formed as a result of glacial scouring. Slopes are stable and below their angle of repose. This is usually less than 60 percent, depending upon the nature of the mantle material. Two stages are recognized - early and late.

Position: Occurs on ridgetops, upper trough walls and truncated spurs.

Surface Features: Drainage pattern reflects the permeability of the parent bedrock and structure. First and second order streams reflect the secondary process on the surface.

Regolith:

1. Early Stage - more than 50 percent of the area is rockland. Rest is skeletal and fragmental family. Includes pockets of thin till and entic residual soils.

2. Late Stage - less than 50 percent of the area is rockland. Remainder of the area is a mixture of thin depositional till and residual soils in the skeletal and fragmental family.

Differentiating Criteria: These units are further subdivided on the Forest level using the following criteria: lithology, structure, reaction, texture and climax vegetation.

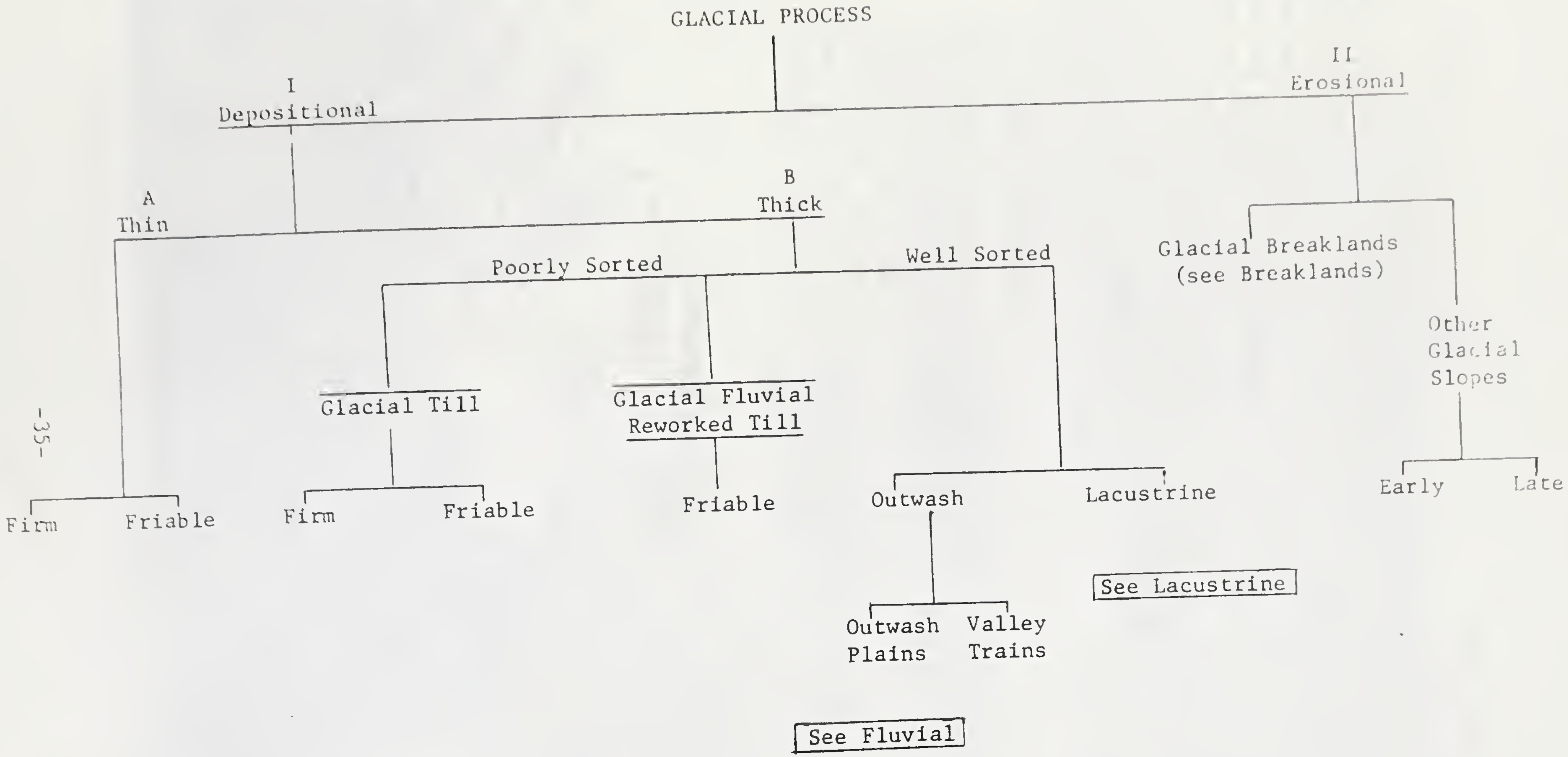

GLACIAL PROCESS
I
Depositional
II
Erosional
A
Thin
B
Thick
Poorly Sorted
Well Sorted
Glacial Breaklands
(see Breaklands)
Other
Glacial
Slopes
Glacial Till
Glacial Fluvial
Reworked Till
Firm
Friable
Firm
Friable
Friable
Outwash
Lacustrine
Early
Late
See Lacustrine
Outwash
Plains
Valley
Trains
See Fluvial

FIGURE II

LACUSTRINE DEPOSITS

Geomorphic Process

Alteration of the earth's surface through erosion and deposition in lakes, thereby developing a characteristic assemblage of landform.

CLASSES

A. Depositional Landforms

A lacustrine plain is the result of a basin being filled during the life of a lake. This plain may lie in mountain valleys, on plateaus, or on larger plains.(7)

Superimposed on the surface of the plain may be a variety of landforms developed by combinations of currents and materials that are characteristic of a lake environment. Examples of these landforms are: deltas, spits, bars, and wave-built terraces.

Lacustrine deposition with subsequent erosion by fluvial action.
Idaho Panhandle N. F.'s (Kaniksu Area)

Surficial Features:

1. Low relief of the original lakebed surface.

2. Relatively uniform elevation along the margin of the plain.

3. Shallow "U"-shaped, first-order drainages on the surface of the plain, with low uniform gradient.(12)

4. Shore drift that is wave-built and has a lakeward dip.

   a. Moderately deep to very deep first order drainages with moderately steep gradients.

   b. Gulch fill(1) has deeply incised streams with steep gradients at the lip of the fill.

Materials: Deposits in a lake environment are usually fairly uniform in texture and are often characterized by varved sands, silts and clays. Along lakeshores, deposits may consist of gravel or sand, but will become finer textured as the distance from shore increases.(7)

B. Erosional Landforms

Removal of weathered debris from a lakeshore line by the mechanical action of waves, results in a wave-cut terrace or a wave-cut plain after the lake has disappeared. A wave-cut cliff is usually created during the erosional process.

The most important erosional forces which created these landforms are: (1) mechanical abrasion by sand and boulders which are propelled by wave action at the cliff foot; (2) hydraulic action (air compression in joints and other openings); and, (3) biologic agents which aid in weathering.(6)

Surficial Features:

1. Bench with a relatively uniform elevation along its margin with higher ground.

2. In mountain areas a terrace often appears as a notch at the end of a ridge. Notches on a series of ridges will be at approximately the same elevation.

3. Terraces are located along mountain slopes above valley floors.

4. Low relief on the wave-cut area with the exception of highly resistant materials remaining above the surface.

5. A wave-cut cliff immediately above the lakeshore line will be significantly steeper than the rest of the land farther from the lake.

6. Moderately deep, V-shaped, first-order drainages with steep gradients at the terrace edge.

7. Wave-built terraces are often found adjacent to wave-cut features.

Materials: Erosional landforms are the result of excavation; therefore, they consist of the pre-existent terrain of the locality.(7) They may be covered with a residual deposit of sand, gravel, and/or cobbles that was being transported when the lake became extinct.

ACCESSORY CHARACTERISTICS

A. Geology (Lithology and Structure)

Established names of bedrock types may be used. Names published in the literature or appearing on geologic maps are acceptable. Where geologic maps are not available, assistance of a geologist may be requested to apply accepted names to the bedrock types.

The physical properties of the bedrock will be described with emphasis on those properties that are reflected in the landform, vegetation, and/or soils. The following properties should be considered: (1) lithology; (2) bedrock hardness; (3) bedrock structure; and, (4) bedrock permeability.

B. Climate

Climatic characterization of landtypes must be adequate to support any limitations to land use in which climatic factors are involved. For example, the degree of stress and portion of the growing season involved should be given when soil plant moisture stress limits establishment of a vegetative cover. Mean annual precipitation and the percentage falling as snow will be used in characterizing landtypes.

PART IV

DOCUMENTATION

DOCUMENTATION

INTRODUCTION

A major concern in the land system inventory is the need for documenting scientific data to support mapping unit descriptions, mapping unit delineations, management interpretations, including the use of laboratory data. Documentation is time-consuming and, often, due to the short field mapping season, it is easy to justify a delaying action in recording scientific data. It is very difficult and unreliable to attempt to recall information months after the field season. A second problem arises with transfer of a soil scientist who has not adequately documented the land system inventory. The replacement soil scientist should not have to cover the same ground to develop documentation that should have been recorded by his predecessor. The new soil scientist should be able to build on the documented information for progressive and accelerated programs. A descriptive legend including field maps and interpretations must be completely documented at the end of each field season and prior to the transfer of the soil scientist responsible for the inventory. In some instances this may require updating and, in others, a complete revision. Periodic inspections should be made to assure documentation.

The need for systematic uniformity in collecting and evaluating interpretive data is essential for resource management areas and unit plans as well as all activity functions.

The lack of good quality pictures is evident in nearly all land system inventories. In order to have quality pictures for report use, it is necessary to have a substantial well-documented picture file. During the field season, one should anticipate the kind of pictures that will adequately illustrate the many complex aspects of the land system inventory including management practices. Black and white, as well as, colored slides are needed for reports, training sessions and slide talks.

Information in the following sections and in other portions of the handbook will assist the Forest soil scientists in collection, recording, evaluation, interpretation of data and prevention of loss of data needed for future use.

DESCRIPTIVE LEGEND

A current descriptive legend is the most important part of the field notebook. It will include information needed to distinguish mapping units from one another. It should also provide information necessary for correlation, classification and to make accurate predictions about behavior and response to kinds of management.

The descriptive legend consists of:

1. Identification Legend - a listing of the mapping units and their identifying symbols.

2. Mapping Unit Descriptions.

Each Forest's land system inventory will have its own descriptive legend. Correlation of landtypes from one Forest to another is not required during the time of mapping. However, it is important to communicate with adjacent Forest soil scientists during the progress of mapping to exchange information in legend development and interpretations. This will make correlation at a future date much easier.

Identification Legend

The identification legend must include a listing of mapping units currently being used and the symbols by which they are identified. This is essential for unit design, identification and clarity to the user. A single identification mapping unit system will be made for each Forest.

Often in a land system inventory, identification legends are undergoing change due to complexity of the area involved and the rapid accomplishments usually expected. In order to maintain a consistent and logical order in the legend, a renumbering of mapping units may be necessary. Therefore, it is necessary that a record of all changes be documented for correlation purposes.

Due to mapping scale and scope of inventory, not all significant features can be delineated. Spot symbols are used to identify significant features too small to delineate due to the mapping scale and yet are large enough to influence use and management. Each Forest is responsible for developing its own legend and should use established symbols.

A current mapping legend will be kept at all times and will be available for review, correlation and inspection by the Regional Office administrative and technical staff.

Mapping Unit Descriptions

A complete description is required for each landtype identified in the Forest's identification legend. The number of field characterizations will vary depending on the complexity of the mapping unit. As the inventory progresses, the concepts of previously defined mapping units may shift, necessitating an annual review and updating of the legend. Sufficient characterizations should be made to assure that mapping unit descriptions are accurate and defensible. Mapping unit characterization data must be readily available for office and/or field review, correlation and inspection as needed.

Each field description will contain enough characterization data to meet the minimum standards specified in the preceding section of guides and standards. Data recording forms (see Appendix) may be used for this purpose.

A copy of the unit descriptive data will be on file for review and critique.

MAPPING UNIT DELINEATIONS

All mapping will be on suitable base and will be indexed for easy access; all mapping unit boundaries will be permanent; major drainages denoted; spot symbols applied where appropriate; mapping unit symbols denoted and all boundaries matched between adjacent sheets. The map sheets will be filed and will be readily accessible for review, inspection and correlation.

LABORATORY ANALYSIS & SAMPLING

Some laboratory analysis will be required for classification and characterization of the soil taxonomic units within the landtype mapping units. Laboratory data will be incorporated in the landtype report.

LANDTYPE SURVEY REPORT

The landtype survey report will be written by the Forest soil scientist and the technical staff involved in making the inventory. The outline for the landtype survey report is in the Appendix.

PART V

LANDTYPE INTERPRETATIONS

LANDTYPE INTERPRETATION

INTRODUCTION

The thought processes used to arrive at interpretations are primarily based upon observations of the response of land to past management practices. This empirical evidence is used to rate lands for the various interpretations. Making interpretations using empirical evidence requires experience and judgment. The more experience the interpreter has with land management within an area, the better are the interpretations using this method.

There have been attempts to devise mathematical guides for making interpretations. The use of these formulas assumes that all factors influencing the interpretation are known; that the relationship of each variable to the interpretation is quantitatively known; and that this relationship is constant for all areas of land. Formula guidelines for rating water erosion hazards are the most common examples of this approach.

Alvis,(2) in a paper entitled An Approach to a Rational Analysis of Soil Erosion Hazard, explored this approach to water erosion hazard evaluation. He pointed out that only if strictly independent variables are considered in the formula can the relationship of variables to erosion hazard be considered constant for all land. He proposed that water erosion hazards are functions of the independent climatic forces which act to move soil and those soil properties which act to resist detachment in movement. He then divided each of these independent variables into component factors, such as rainfall duration and intensity, and soil aggregate stability and mass.

The problem with relying entirely on formula guides for interpretations is that many variable factors are not easily measured by field techniques, and the relationship of variables to interpretation is not always quantitiatively known. This limitation applies not only to water erosion hazards but to all interpretations commonly made. Without exception, they result from the interaction of complex variables whose component factors are difficult to measure by field techniques and whose relationship to the interpretation are not quantitatively known. Slope stability interpretations are probably the best example of this problem.

Therefore, until research quantifies these relationships between independent variables and interpretations, and field techniques for measuring the variables improve, continued reliance on empirical data is necessary. Where formula guides exist, they may be used to rationalize the interpretation arrived at primarily by empirical means. Since making interpretations using empirical data requires experience and judgment, the quality of interpretation will vary from one survey area to another depending upon the experience and judgment of the person making them. As an aid to achieving uniformity, those independent variables which are known to affect the most commonly made interpretations are listed.

SOIL STABILITY LIMITATIONS OR HAZARDS

Discussion:

Traditionally, erosion hazards or limitation ratings have considered the interaction between soil properties which act to resist detachment and movement, and those climatic and slope characteristics which generate forces that act to detach and move soil. The hazard ratings were based on the relative impact of topsoil loss on soil productivity. These ratings are important to agricultural uses of soil in which vegetative cover is periodically removed from large areas of soil, and reduced site productivity is a major impact of erosion. However, management practices applied to National Forest lands, which result in soil disturbance, are usually associated with road construction or timber management. Attempts are made to restore permanent vegetative cover to most areas of soil disturbed by these practices. The total area disturbed in a given landscape is normally small and a major impact of erosion is that of transported sediment on watershed values. An adequate classification of the limitation that erosion hazards place on Forest management practices requires that the probability of transported sediment entering the surface drainage system be evaluated.

Onsite erosion and consequent deterioration of site quality may be an important impact in local areas where management practices result in significant areas of soil disturbance.

Delivery Efficiency:

Wilson and Bennett(14) have defined a factor called delivery efficiency which rates the efficiency with which water and sediment are transported by different landforms. Essentially, delivery efficiency is a function of the amount of surface runoff produced by a landform and the gradient and ordering normality of the low-order channels which transport water and sediment from the landform. They define components of this factor as:

1. Overall slope shape.
2. Percentage of the landtype drained by low-order streams.
3. Ordering normality of the stream.
4. Average slope gradient of the landtype.
5. Soil depth.
6. Soil internal drainage.

These factors are interdependent, however, and relationships between them are likely to vary from place to place.

Examples of various landtype ratings and characteristics are illustrated in the following table:

Class	Example
1	Low Stream Terraces
3	Strong and Moderately Frost-Churned Uplands
5	Weakly Frost-Churned and Colluvial Slopelands
7	Frost-Churned Breaklands and Plastered Trough Walls
9	Young Stage Fluvial Breaklands and Scoured Trough Walls

Delivery Efficiency	Slope Shape	0/0 1st Order Streams	Ordering Class	Avg. Slope 0/0	Soil Depth	Soil Internal Drainage
Class 1	Flat	0-20	None	0-20	10'+	Moderate
3	Convex	20-40	1-2-3	20-40	6-10'	Rapid
5	Wk. Convex and Flat	40-60	1-3+4	40-60	4-6'	Rapid
7	Flat and Convex	60-80	1-4	60+	3-6'	V. Rapid
9	Concave	80+	1-4	60+	3'	Excessive

The delivery efficiency factor is a qualitative rating. If the water yield from a specific landform is entirely by subsurface flow, a rating of "1" is made. A rating of "9" is given to landforms having all surface flow. These landforms are often characterized by steep slopes and low-order channels. Other landforms are rated between these two extremes.

Delivery efficiency is averaged with onsite erosion hazard ratings to obtain an offsite sediment hazard rating. When the hazard rating is very low or delivery efficiency is "1", the offsite sediment hazard rating is always low, regardless of the value of the other factor.

Onsite Erosion Hazards (Independent Variables):

1. Water Erosion

The following model will be used to develop erosion hazard ratings. Individual ratings will be developed for natural surfaces and areas disturbed by management activities, such as roads, skid trails, landings, etc. When rating disturbed soils, consideration must be given to reduced infiltration rates, soil structural alteration and changes in vegetative recovery rate. The dgree of disturbance should be defined or the practice which creates the disturbance described for each practice rated.

a. Forces Acting

1) Rate and duration of rainfall or snowmelt rates.

2) Soil infiltration rates.

3) Slope gradient.

4) Slope length.

b. Forces Resisting

1) Strength of surface aggregates.

2) Mass of surface aggregates.

3) Coefficient of friction between aggregates.

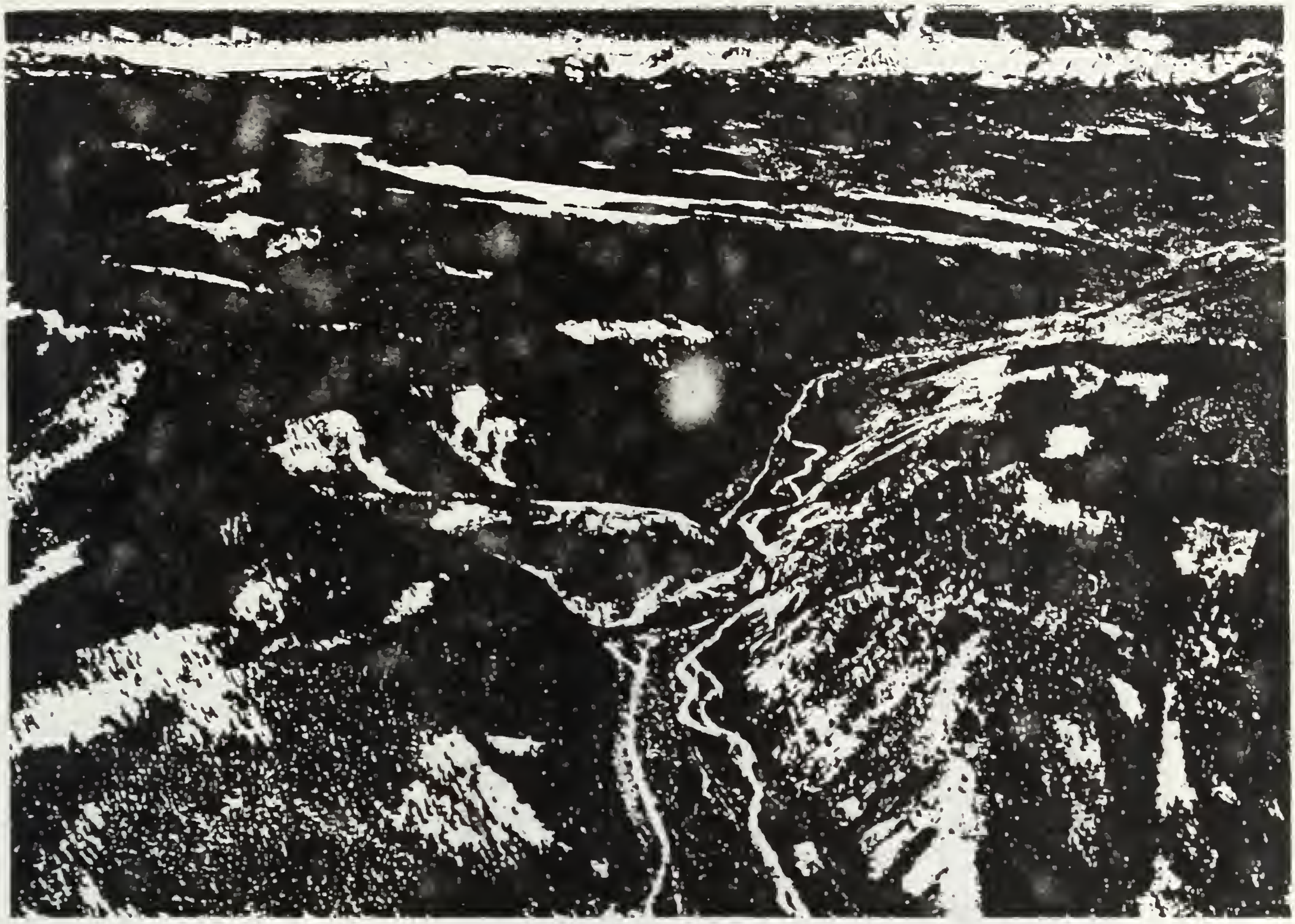
4) Vegetative recovery rate.

5) Slope roughness.

2. Rotational Mantle Slumping

Rotational landslips or slumps are mantle failures that take place, usually fairly rapidly, by shearing on a well-defined, concave slip surface. Failure imparts a backward rotation to the slipping mass, producing sinking at the rear and heaving at the toe of the landslip.

Estimates of shearing stress, pore water pressure, and shearing resistance are used in developing slump hazard ratings. Factors considered in estimating potential shearing stress and pore water pressure include slope gradient, bulk density, depth to bedrock, differential permeabilities of soil and bedrock, soil porosity, soil water regimes, and slope forming processes. Factors considered in estimating shearing resistance include soil texture, grain shape and arrangement, and plasticity.



Rotational Mantle Slump - Taylor Fork - Gallatin N. F.

a. Forces Acting

1) Mantle mass (gravity).

2) Slope gradient.

3) Concentration of subsurface water.

b. Forces Resisting

1) Internal strength or coefficient of friction of mantle material.

2) Vegetative cover.

3) Mantle depth or water detention capacity.

Note: In actual practice, mantle slumping hazard predictions are based entirely on empirical evidence. Attempts to predict the aforementioned hazard using a theoretical basis is very difficult.

3. Debris Avalanche Hazard

Debris avalanche refers to the rapid and usually sudden sliding and plowage of unsorted mixtures of soil and rock material. Often, landtypes with this hazard will contain evidence of the processes operating in the past, such as talus slopes and colluvial cones, which aid in identifying the hazard.

Debris Cone Below Avalanche Chute - Graves Creek
Flathead N. F.

a. Forces Acting

1) Slope gradient.

2) Concentration of subsurface water.

3) Slope shape.

4) Accumulation of mass of material at head of drainageways.

b. Forces Resisting

1) Vegetative cover.

2) Internal strength or coefficient of friction of mantle material.

3) Mantle depth or water detention capacity.

4. Dry Soil Creep

a. Forces Acting

1) Slope gradient.

2) Aspect.

b. Forces Resisting

1) Soil coherency or coefficient of friction between soil aggregates (soil detachability index).

2) Vegetative cover.

Hazard Ratings:

Soil stability hazard ratings are defined in terms of intensity of soil management practices needed to prevent accelerated erosion or increased sedimentation of surface waters and the practicality of applying these practices. Risks are potential adverse impacts resulting from management practices applied to land with hazards. In the case of erosion hazards, risks include such impacts as reduced site productivity, sediment pollution of surface waters and sedimentation of lakes and reservoirs. Risk analysis commonly involves factors not measured in the land system inventory, such as location of the proposed practice relative to streams or lakes and relative values of practices proposed to values of resources adversely impacted.

1. Stability Hazard Ratings Defined

a. Very Slight

The hazard does not occur on the landtype; for example, dry soil creep on alluvial flood plains.

b. Slight

The hazard occurs, but the limitation to management is minor and can be easily overcome by relatively inexpensive and commonly used control practices.

c. Moderate

The hazard imposes a limitation on management which can be overcome with special planning, design, or maintenance. The cost of the practice may be increased but not sufficiently to make it impractical to apply.

d. Severe

The hazard imposes limitations on management which are difficult and costly to overcome. Expensive design modification or intensive maintenance practices are required.

e. Very Severe

This rating is a subdivision of the severe rating which separates those lands on which the limitation is so severe that for most purposes the land should not be used for the use rated.

PRODUCTIVITY

Introduction

Productivity is a function of soil and climatic properties. This interaction is often complex and difficult to evaluate. Habitat types act as integrators of those surficial soil and climatic factors influencing plant growth. Although the productivity range of a given habitat is often wider than desired by map users, the range for a landtype can often be narrowed by using soil or landform properties. Therefore, productivity ratings for landtypes are based upon the ratings given for the habitat types they contain with some restrictions of the productivity range often applied.

Timber Productivity

When the productivity range of habitat types must be subdivided to separate lands with significantly different productivity, a landtype quality rating should be used in conjunction with the habitat type. This rating will indicate the relative position of the landtype within the habitat type's productivity range and the factors responsible for restricting the productivity range. These ratings should be qualitative unless they have been quantitatively defined by a forester competent in mensuration.

These landtype quality ratings will not be required for all habitat types since some are confined to specific soil and landform conditions. Those which occur over broad geographic areas on a wide variety of soils and landforms will most often require refinement in the productivity rating.

Examples of Productivity Ratings

Landtype	Dominant Habitat Type	Landtype Quality Modifier	Yield Capability Class
61-1	DF/Syal, Caru Phase	Low 1/3	IV
11-10	DF/Syal, Caru Phase	Low 2/3	III
61-6	AF/Mefe	Low 2/3	III
20-6	AF/Caca	None	II or III

In this hypothetical example the first two landtypes are classified in the same habitat type. However, the first occurs on high energy south-facing slopes on which productivity is restricted to the lower one-third of the productivity range given for the habitat type. The second landtype consists of coarse-textured glacial outwash terraces on which low water holding capacity in the bouldery, sandy substrata restricts overstory productivity to the lower two-thirds of the range given for the habitat type. The third landtype consists of steep, glacially scoured valley walls. Soils are relatively shallow, and rooting depth is restricted by dense rock at shallow depth. Maximum potential productivity is estimated to be in the lower two-thirds of the range given for the habitat type. The fourth landtype consists of poorly drained glacial deposits at high elevations and the habitat type is restricted to similar conditions; therefore, no landtype quality modifier is required.

Modifying factors can be defined in footnotes to the interpretive table. Regionally defined yield capability classes are taken directly from the habitat type classification unless better local data have been developed.

Productivity Ratings for Natural Grasslands

These ratings are applied to all lands supporting vegetation which are incapable of supporting a forest climax. Coniferous trees may occur on these lands as accidentals or invaders but are not a consistent component of climax communities.

Potential Productivity

This section contains three columns.

a. A habitat type classification on Mueggler and Handl's[8] classification for grass and shrub habitat types of Western Montana; Daubenmire's[5] Forest Vegetation of Eastern Washington and Northern Idaho or locally devised systems for areas beyond the area covered by these publications.

b. A column listing modifiers which restrict the range of productivity for a habitat type on a given landtype. This column will include soil properties which affect the quality and quantity of growing space and landtype properties such as aspect, elevation and slope which are not adequately classified by the habitat type system.

c. A column rating potential productivity. Where adequate local clipping studies are available, these ratings will be made by quantitative classes. Where clipping studies are not available, a relative ranking of the productivity of lands within the survey area will be made. Three or five classes may be used depending upon the range of productivity which occurs in the survey area.

Discussion

Habitat types act as integrators of environmental factors that affect climax plant communities. In some cases the productivity range of the overstory species adapted to a habitat type may be too broad for uses of the land inventory. This is due to the fact that the quality of part of the plant growth environment is not always classified in the habitat type classification system.

Alpine Fir - Beargrass Habitat Type in foreground - Clearwater N. F. (Lolo Trail)

Daubenmire maintains that the climax forest overstory and climax understory union exist independently of one another; the climax overstory being a function of macroclimatic factors and the climax understory a function of local variations in microclimate or soil conditions. If this is true, the climax understory union can only be indicative of soil and moisture conditions within the rooting zone of the understory. This will usually be less than the rooting depth of the overstory, especially where the understory is composed of grasses and forbs. The qualities of that zone between the lower rooting depth of the climax understory and overstory is therefore not measured by habitat type classification.

The qualities of this zone are often important to overstory productivity. Refinement of productivity ratings for habitat types is possible with landtype surveys because the qualities of this zone are predictable, using the soil and landform qualities classified in the landtype inventory.

In some cases the habitat type system may not adequately separate significant microclimatic variations that occur with variations in slope or aspect. These variations are usually separable using the habitat type phase; however, when appropriate phases have not been defined, this variation can be handled in the landtype classification by using solar energy loading as a criteria. These microclimatic modifiers need not be used when appropriate habitat type phases have been defined.

OPERABILITY

In a column listing limitations to travel across the land, the degree of limitation to the major land uses for which the land is suited should be included. These commonly include slope, rock outcrop, surface stones and boulders and wet ground.

Many of these limitations will have already been reflected in suitability ratings.

SOIL COMPACTION

Soil compaction is difficult to evaluate and variable results have been reported. Some results have been very significant while others have been inconclusive. Also, the methodology and equipment used to measure soil compaction has provided different results. Even small amounts of soil compaction can adversely affect tree physiology such as physical impedence to roots, gaseous exchange (macroporosity reduction) and nutrient and moisture movement. The actual physical changes in the soil that affects vegetation most is one of reduction of non-capillary pore space which in turn reduces infiltration, permeability and gaseous exchange.

The potential for soil compaction (interpretation) on various landtypes should be indicated even though the total impact may be unknown. This information should serve as preliminary notification to land managers that a potential compaction problem exists and that further detailed onsite examination and evaluation is needed before specific plans are completed.

OTHER LIMITATIONS TO USE

Most interpretive tables will require a section for limitations to use such as: flooding, avalanches, and persistent snowbanks. The nature of the limitation and degree of limitation must be listed.

SUITABILITY RATINGS

Suitability ratings for specific forest management practices are often requested. Commonly, suitability for different logging systems, road construction, sewage disposal fields, campgrounds, etc. are requested. Specialists in applying the practice being rated should always be consulted when making these ratings. The practice for which suitability ratings is being made must be specifically defined since variations in practices, such as road standards and logging equipment in use, are often important factors in determining suitability. As an example of how suitability ratings should be made the following section on how to rate grazing suitability is included.

1. Grazing Suitability Ratings

Limitations defined: A section describing the limitations to use by grazing animals and the degree of limitation is recommended. These limitations should be listed for each class of grazing animal using the lands in the survey area; for example, sheep or goats, cattle or horses, elk or deer.

The following limitations will most often need to be rated:

a. Access limitations due to slope

Example: No limitation. Landforms with average slope less than 20 percent. The entire mapping unit is capable of being primary range.

Example: Moderate limitation. Average slope between 20 and 50 percent. Major portions of the mapping unit are secondary range because of slopes too steep for regular use by the animals rated for.

Example: Severe. Most of the mapping unit is too steep for regular use by the animals rated for. Potential primary range is restricted to narrow stream bottoms or ridgetops which occupy a minor part of the mapping unit.

b. Trafficability

This limitation applies to soils which are saturated with water during part of the grazing season. Grazing use when the soils are water-logged produces unacceptable trampling damage to soils and vegetation.

c. Recovery rate after disturbance

A rating of the limitation imposed on grazing use by very dry or cold climates which create long secondary successional stages for the climax vegetative community. Examples are alpine or arid areas which recover very slowly from grazing damage, even with proper management. The climax community may be highly productive but is so fragile that unusually stringent management practices are required to prevent long-term decline in productivity.

d. Length of grazing season

A rating of the limitation to use due to climatic factors which limit the length of the grazing season. Snow, extreme temperatures, and high winds are examples of these limtations.

2. Forest Understory Suitability for Grazing

Suitability of the understory vegetation for grazing by livestock or wildlife is recommended. In addition to productivity, suitability ratings must take into account species composition, availability of forage to the grazing animals, and changes in understory vegetation with secondary succession.

Separate ratings are required for each species of grazing animal because of varying food preferences and capability to overcome access limitations such as slope or snow on winter game ranges.

The successional stage for which suitability is rated must be defined. Most often it will be the early stages that occur in clearcuts or burns.

As with all suitability ratings, specialists in the use being rated for should be consulted. Range and wildlife specialists should identify those suitability ratings which are most valuable to the survey users.

Ratings of total understory productivity without regard to food preferences or accessibility are relatively easy to make but have little value to the survey user and should be avoided.

RELIABILITY OF INTERPRETATIONS

The level of reliability of interpretations is a function of mapping scales used in the field inventory and intensity of field examination of the mapping units. The techniques used to plot mapping unit boundaries, and the size of inclusions with different management properties within the mapping unit should be described for the survey user so that he can judge reliability. The types of uses for which the map is adapted must also be defined.

1. Level III - Landtype

All mapping unit boundaries have been observed in the field, although not necessarily plotted on the ground. Observation may have been from a topographic vantage point or from an aircraft. Representative delineations of mapping units are characterized on the ground but all are not actually examined. Inclusions may be from 10 to 100 acres (24.7 to 247 hectares) in size and not more than 15 percent of total area, depending upon mapping scale.

2. Level IV - Landtype Association

Mapping unit boundaries are plotted primarily by photo interpretation. Many boundaries have not been actually observed. Representative delineations are described on the ground to characterize the delineations not examined in the field. Inclusions may be from 10 to 100 acres (24.7 to 247 hectares) in size, depending upon mapping scale.

Quantification of Soil Responses

Any useful quantification of a soil parameter for field application assumes the state of the art is sufficiently advanced that usable, precise values are available. In general, absolute values are not presently at hand for many soil parameters of interest. Relative value approaches, or the use of probability, are the best alternatives. Neither is very satisfactory.

PART VI

APPENDIX

1) Data Recording Forms

2) Outline for Landtype Survey Report

DATA RECORDING FORMS

EXPLANATION OF FORMS

Landtype Description

This is designed to serve as a field form which will fit soil color sized notebooks. The form has entries for all the landtype standards obtainable from field observations. Entries should follow the landtype standards and be quantitative insofar as possible; i.e., adjectives should not be used where the use of quantitative classes are possible. This will facilitate the formation of a computer data bank necessary to most computer programs at a later date.

Landtype Data

This is designed as the single office form for summarizing all the characteristics of a landtype as well as summarizing responses useful to computer programs. All of the characterization entries (soil profiles and above) will be obtained from the landtype description forms, plus the office-compiled climatic and hydrologic characterizations. Certain other characterization entries, e.g., extent on Forest, reference to modal sites, and soil classification will be entered following the formation of the modal concept of the landtype based on the landtype descriptions. On surveys which will not have computer analyses, all the entries beneath the soil profile description will not be completed.

Cell Description

This form is designed to provide data essential to the RCS program of current uses and conditions on an area-by-area basis. On surveys not currently oriented to computer programs, collection of this type of data is not ordinarily collected, and use of the form will not be necessary.

Examples of these three forms follow on the succeeding pages.

LANDTYPE DESCRIPTION

LANDTYPE NAME	SYMBOL	DATE	BY
MODALITY	PHOTO NO.	PHOTO POINT	
SURVEY AREA	FOREST	DISTRICT	
GEOL. FORMATION NAME	LITHOLOGY		
BEDROCK HARDNESS	STRUCTURE		
ASPECT	ELEVATION	BEDROCK PERM.	
GEOMORPHIC PROCESS AND/OR STRUCTURAL CONTROL			
OVERALL SLOPE GRADIENTS	OVERALL DEPTH TO BEDROCK	INTERNAL DRAINAGE CLASS	
SNOW PERSISTENCE	SURFACE COARSE FRAG.	ECOLOGICAL (HABITAT) TYPE	

MAJOR HORIZON	THICKNESS	COLOR	STRUCTURE	CONSISTENCE	TEXTURE	COARSE FRAGMENTS	PERME- ABILITY	BULK DENSITY	OTHER

DIAGNOSTIC HORIZONS PRESENT____________________ LITTER THICKNESS____________________

(UNIT OF SOIL, AIR, WATER, MINERALS & GEOLOGY - JUNE 1976)

(NOTE: This form is printed on 7 x 8¼ inch, green-colored card stock.)

LAND TYPE DATA

LAND TYPE NAME	MAP NUMBER	DATE	SURVEY AREA	FOREST	EXTENT ON FOREST	REFERENCE

GEOL. FORMATION NAME	LITHOLOGY	BEDROCK HARDNESS	STRUCTURE

AVG. ANNUAL PRECIP.	AVG. % AS SNOW	15-MIN. MAX. INT.	WATER LOSSES	AVG. ANNUAL AIR TEMP.	GROWING SEASON	AVG. ANNUAL H20 YIELD	RUNOFF TIMING (AVG. JULIAN DATE)	SNOW PERSISTENCE

PLANT AVAIL. MOISTURE STRESSES	OVERLAND FLOW	GEOMORPHIC PROCESS AND/OR STRUCTURAL CONTROL

POSITION	LOS* LATERAL SPACING (DRAINAGE DENSITY)	LOS* ENTRENCHMENT	LOS* REACHES	LOS* GRADIENTS

LOS* BEDS	STREAM ORDERING	% AREA IN LOS* VALLIES	LOI+ LATERAL RELIEF	LOI+ LATERAL SLOPE SHAPE

LOI+ LATERAL SLOPE GRAD.	OVERALL LOCAL RELIEF	OVERALL SLOPE GRAD.	DEPTH TO BEDROCK	INTERNAL DRAINAGE CLASS

ECOLOGICAL (HABITAT) TYPE(S)	LITTER THICKNESS	OVERALL SLOPE SHAPE

DIAGNOSTIC HORIZONS	SURFACE COARSE FRAGMENTS	SOIL FAMILIES

MAJOR HORIZON	COLOR	THICKNESS	STRUCTURE	CONSISTENCE	TEXTURE	COARSE FRAGMENTS	PERMEABILITY	BULK DENSITY	OTHER

INFILTRATION	TOTAL SOIL DETENTION CAPACITY	TOTAL SOIL RETENTION CAPACITY	BEDROCK PERM.	AVALANCHE HAZARD	FLOOD HAZARD

VEGETATIVE GROWTH POTENTIAL			STABILITY			
RELATIVE	QUANT. (MGT. LEVEL A)	QUANT. (MGT. LEVEL B)	RELATIVE HAZARD		EROSION RATES	
TIMBER	TIMBER	TIMBER	EROSION NATURAL SURF.	ROAD CONSTR. (STAND. A)	VEG. MANIPULATION (TYPE A)	MGT. PRACTICE (A)
HERBAGE	HERBAGE	HERBAGE	EROSION ROAD CUTS	ROAD CONSTR. (STAND. B)	VEG. MANIPULATION (TYPE B)	MGT. PRACTICE (B)
BROWSE	BROWSE	BROWSE	EROSION ROADBEDS	ROAD MAINT. (STAND. A)	LAND USE (USE A)	MGT. PRACTICE (C)
GROUND COVER	GROUND COVER	GROUND COVER	EROSION ROAD FILLS	ROAD MAINT. (STAND. B)	LAND USE (USE B)	MGT. PRACTICE (D)
			MASS FAILURE ROAD CUTS	PRISTINE	EXISTING	
			GULLYING			
			SURFACE DRY CREEP			
			BLOWOUT			

*LOW ORDER STREAMS

+INTERFLUVES OF LOW ORDER STREAMS

DIVISION OF SOIL, AIR, AND WATER MGT., MAY 1972

(Note: *This form has been reduced from size 10½ x 12¼ inches for inclusion in this report*)

CELL DESCRIPTION

CELL NUMBER	LANDTYPE NAME	LANDTYPE SYMBOL
MODALITY	WATERSHED NO.	ACREAGE

TIMBER COMPOSITION	RANGE TYPE
TIMBER STOCKING	RANGE CONDITION
TIMBER SIZE (AGE) CLASS	EROSION CONDITION
LITTER THICKNESS	GULLIES
SURFACE COARSE FRAGMENTS	GROUND COVER
CHANNEL CONDITION	HAZARDS (FLOOD, AVALANCHE, ETC.)
WATER USE ONSITE	MINERAL POTENTIAL
WATER USE OFFSITE	KIND OF MINERALS
FISHERY CLASS. OF MAJOR STREAM	VIEW AREA
DISTANCE TO MAJOR STREAM*	SCENIC AREA
EFFECTIVENESS OF FILTER FIELD	RECREATION POTENTIAL
ADMINISTRATIVE ZONING	WILDLIFE USE
	SEEPS AND SPRINGS

HAZARDS, POTENTIALS, AND RESPONSES DIFFERING FROM MODAL LANDTYPE

*Distance - Stream Order

MAJOR OUTLINE FOR LANDTYPE SURVEY REPORT

NO OUTLINE WILL MEET THE NEEDS OF ALL, AND SOME AUTHORS PREFER SOMEWHAT DIFFERENT ARRANGEMENTS OF THE SECTIONS. USE THIS AS A GUIDE TO WORK OUT AN OUTLINE TO FIT THE NEEDS OF YOUR FOREST.

I. INTRODUCTORY SECTION

A. FRONT COVER

B. LOCATION MAP (can be on inside of front cover or it can fold out from the back cover)

Give the location & principal highways leading to the area. Show location in the State.

C. CREDIT PAGE

Name and title of individuals who worked on survey, prepared report, and/or sections of report. Other agencies who cooperated in report.

D. PREFACE (optional)

E. TABLE OF CONTENTS

F. INTRODUCTION

1. Objectives
2. Procedures or Study Methods
3. Limitations
4. Use of Survey Report
5. General Nature of the Area
   Natural & Cultural Geography
   Size and Composition
   Land Use History - Important highlights of early
                      and current history, etc.
   (Much of this type of information is already available in Part I, MU Plan for your Forest.)

II. INVENTORY SECTION

Some authors prefer to place the Interpretations section ahead of the Inventory section. This sequence is optional.

A. OVERVIEW (should include a generalized discussion of the various inventoried data and reliability of data.)

1. Geology

2. Landform & Process

3. Soils

4. Climate

5. Hydrology

6. Vegetation

7. Drainage Systems (separately or as part of Hydrology)

Detailed supportive data may be listed in appendix, including:

Source of Data
Analysis of Data
Presentation of Data

B. SUBSECTION MAP

Most soil scientists will have a subsection map of their Forest by the time they are ready to write the Landtype Report. It is an excellent tool to integrate the various inventoried data and to introduce the reader to separate broad areas with differing kinds of natural hazards or potentials.

Brief discussion on how subsection maps are made, their use, and interpretations that can be made from them.

C. LANDTYPES

1. Landtype Identification Legend

   This is a listing of landtype units by their identifying symbol and name.

2. Description of Landtypes (mapping units)

   a. Identify by symbol

   b. Physiography - Discuss

      Geology (lithology & structure)
      Landform
      Process of Formation
      Slope Range
      Aspect
      Elevation

c. Soils

Briefly describe the soils for each landtype. Include gross characteristics for each of the major profile horizons: topsoil, subsoil, and substratum (soil) and/or substratum (geologic).

Characteristics are inferred as well as observed and measured. Describe the important inclusions. Place the mapping units in the new Soil Taxonomy Classification System of the National Cooperative Soil Survey. Classify the units to the suborder or family level.

d. Vegetation

Listing of habitat types or habitat type groups. Include description of composition: range, complexes and intergrades where needed.

e. Climate

List important climatic factors such as:

Average annual precipitation
Percentage of precipitation falling as snow
Fifteen-minute maximum storm intensity
Periods of soil moisture stress
Snow persistence
Growing season
Potential evapotranspiration (qualitative)

III. INTERPRETATIONS

Discussion on approach used to arrive at the various interpretations.

Refer to Region 1 Handbook section on "Guidelines for Making Landtype Interpretations" in your writeup. Describe any changes that were made from those in the handbook. Use the appendix to show an example of methods used.

A. SOIL LIMITATIONS AND HAZARDS

1. Slope Stability

2. Wetness

3. Windthrow

4. Frost Heave
5. Compaction
6. Sediment Delivery Rate
7. Rockiness & Stoniness
8. Etc.

B. SUITABILITIES AND OPPORTUNITIES

1. Productivity
2. Silviculture
3. Livestock Range
4. Wildlife Habitat
5. Fire Management
6. Recreation Development
7. Road Locations
8. Etc.

IV. GLOSSARY OF TERMS

List those terms in text that are not covered in a College Edition dictionary and those which have a special meaning not given in such a dictionary. Emphasize explanations rather than true definitions.

V. LITERATURE CITED

(A listing of selected references actually quoted, paraphrased or used to support ideas in the report. List references alphabetically.)

VI. APPENDIX

Include supporting data to text.

Examples:
    Technical Soil Descriptions
    Laboratory Data
    Examples of Methods that are not in R-1 Handbook

VII. MAP ATLAS

These are the most common base maps used. The one selected will depend upon the needs of each Forest. The preferred map scales are 1:31,680 or 1:63,360.

1. Topographic
2. Photo Mosaic
3. Orotho-Photo
4. Planometric

PART VII

GLOSSARY

GLOSSARY

Cirque - possessing three distinctive elements: a steep, nearly vertical headwall, a concave floor meeting the headwall in a sharp break of slope and a lip or threshold at the entrance which may be bedrock, a local moraine or both.

Clipping Plots - in range used to determine plant production, utilization and percent composition. Plots are clipped and weighed from a small sample area (usually .96 square feet or 9.6 square feet) to determine yield per acre. In range unpalatable species are not included.

Colluvial - consisting of alluvium in part and also containing angular fragments of the original rock; also talus and cliff debris.

Consistence - the resistance of a material to deformation or rupture.

Cryic - a soil temperature regime. Very cold soils having a mean annual temperature higher than 0°C (32°F) but lower than 8°C (47°F).

Drumlins - a smooth, streamlined, dome-shaped hill formed beneath flowing glacial ice.

Esker - sinuous gravel and sandy ridge of alluvium, laid originally in ice-walled tunnels and exposed when the glacier melted.

Fault Escarpment - an escarpment that coincides more or less closely with a line of faulting; the escarpment occurring on the high side of the dislocation.

Habitat Type - is the aggregation of units of land capable of producing similar plant communities at climax.

Hummucky - small uneven knolls.

Kames - an irregular ridge or hill of stratified glacial drift.

Lacustrine - depositional materials produced by or belonging to lakes.

Landform - a terrain feature formed by natural processes which have a definable composition and range of characteristics that occur wherever that landform is found.

- also, a characteristic association of surficial land features, developed by a particular geomorphic process.

Lithology - the study of rocks.

Nivational - whenever a drift (snowdrift) is found, a process is set in operation, the effect of which is to hollow out and lower the ground beneath it.

Pergelic - a soil termperature regime. Soils with permafrost having temperature regimes with a mean annual temperature lower than 0°C.

Pluvial - pertaining to deposits by rainwater or ephemeral streams.

Regolith - the unconsolidated mantle of weathered rock and soil material on the earth's surface.

Secondary Process - a process taking place at the same time as a primary process involving any phenomenon which shows a continuous change in time; such as, denudation or deposition by sculpturing forces (wind, water, ice, etc.).

Skeletal - belonging to a group of shallow soils composed chiefly of rock fragments usually on steep mountainside slopes.

Varves - laminations in lacustrine deposits.

PART VIII

REFFERENCES

REFERENCES

(1) Alden, W. C., 1953, "Physiography and Glacial Geology of Western Montana and Adjacent Areas," Geological Survey, Professional Paper 231, 200 p., U. S. Government Printing Office.

(2) Alvis, R. J., 1960, "An Approach to a Rational Analysis of Soil Erosion Hazard," International Association for Scientific Hydrology.

(3) Bailey, R. G., 1976, Preliminary Report, "A Regional Approach to Ecosystem Classification for Purposes of Resource Inventory," U. S. Forest Service, Ogden, Utah.

(4) Cline, M. G., 1949, "Basic Principles of Soil Classification," Soil Science 67:81-91.

(5) Daubenmire, R. and Daubenmire, J. B., 1968, "Forest Vegetation of Eastern Washington and Northern Idaho," Washington Agriculture Experiment Station, Washington State University, Pullman, Washington.

(6) Fairbridge, R. W., 1968, "The Encyclopedia of Geomorphology," Reinhold Book Corporation, New York, N. Y.

(7) Howell, J. V., 1957, "Glossary of Geology and Related Sciences," Second Edition of Geology and Related Sciences, American Geology Institute, Washington, D. C.

(8) Mueggler, W. F. and Handl, W. P., Interim Report, 1974, "Mountain Grassland and Shrubland Habitat Types of Western Montana," U. S. Forest Service, Intermountain Forest and Range Experiment Station and Northern Region, Missoula, Montana.

(9) Pfister, R., et al., 1974, Preliminary Report, "Forest and Range Habitat Types in Montana," U. S. Forest Service, Intermountain Forest and Range Experiment Station and Northern Region, Missoula, Montana.

(10) Soil Survey Manual, Agricultural Handbook No. 18, U. S. Department of Agriculture, U. S. Government Printing Office.

(11) Thornbury, W. D., 1954, "Principles of Geomorphology," Wiley & Sons, Inc., New York, N. Y.

(12) Way, D. S., 1973, "Terrain Analysis: A guide to Site Selection Using Aerial Photographic Interpretations," Dowden, Hutchinson & Ross, Inc., Stroudsburg, PA.

(13) Wertz, W. and Arnold, J. A., 1973, "Land Systems Inventory," U. S. Forest Service, Intermountain Region, Ogden, Utah.

(14) Wilson, D. and Bennett, M., 1975, Unpublished - "Clearwater National Forest Watershed Analysis Procedure," U. S. Forest Service.

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